A TIME SERIES ANALYSIS OF PRICES AND EXCHANGE RATES IN EUROPE TOWARDS THE THIRD STAGE OF EMU

by

OYA PINAR ARDIÇ

Department of Economics
Bilkent University
Ankara

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OYA PINAR ARDIÇ

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I certify that I have read this thesis and in my opinion it is fully adequate, in scope and quantity, as a thesis for the degree of Master of Arts in Economics.

Faruk Selçuk
Assistant Professor

I certify that I have read this thesis and in my opinion it is fully adequate, in scope and quantity, as a thesis for the degree of Master of Arts in Economics.

Serdar Sayan
Assistant Professor

I certify that I have read this thesis and in my opinion it is fully adequate, in scope and quantity, as a thesis for the degree of Master of Arts in Economics.

Nedim Alemdar
Assistant Professor

Approval of the Institute of Economics and Social Sciences
Director:

ABSTRACT

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Oya Pınar Ardıç

Department of Economics

Supervisor: Asst. Prof. Faruk Selçuk

July 1998

This thesis analysed prices and exchange rates of eleven EMU States using time series analysis. Among the criteria set by the Maastricht Treaty as requirements of participating in the euro zone, price stability and exchange rate convergence were examined. The answers for the questions such as whether or not the prices and exchange rates move together permanently, and the PPP hypothesis holds for euro against US dollar, Japanese yen and Turkish lira were investigated. For these purposes, real exchange rate indices for the euro zone were calculated using the data on prices and nominal exchange rates. The prices, bilateral nominal and real exchange rates of the EMU States were found to have a long-run equilibrium relationship among themselves. However, there was no evidence of PPP for euro against US dollar, Japanese yen and Turkish lira.

Keywords: EMU, prices, real exchange rate, nominal exchange rate, unit root, cointegration, PPP hypothesis.

ÖZET

AVRUPA PARA BİRLİĞİNİN ÜÇÜNCÜ AŞAMASINA DOĞRU FİYATLARIN VE DÖVİZ KURLARININ ZAMAN SERİLERİ ANALİZİ

Oya Pınar Ardıç

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Tez Yöneticisi: Yrd. Doç. Faruk Selçuk

Temmuz 1998

Bu çalışmada, Avrupa Para Birliğine (APB) katılacak olan onbir ülkenin fiyat endeksleri ve döviz kurları incelendi. Maastricht Anlaşmasının APB'ye katılabilmek için ortaya koyduğu şartlardan fiyat istikrarı ve döviz kuru yakınlaşması üzerinde duruldu. Bu çalışma, fiyatların ve döviz kurlarının uzun vadede kalıcı olarak birlikte hareket etmelerini ve euro ile Amerikan doları, Japon yeni ve Türk lirası arasında Satınalma Gücü Paritesi (SGP) hipotezinin geçerliliğini araştırdı. Bu amaçla, fiyat ve nominal döviz kuru endeksleri kullanılarak APB'ye üye ülkeler için reel döviz kuru endeksleri hesaplandı. APB ülkeleri için fiyatlarrm ve döviz kurlarının uzun vadede kendi aralarında denge ilişkisinde bulunduğu saptandı. Ancak, euro ile Ameraikan doları, Japon yeni ve Türk lirası arasında SGP hipotezinin geçerliliği kanıtlanamadı.

Anahtar Kelimeler: APB, fiyatlar, reel döviz kuru, nominal döviz kuru, birim kök, eşbütünleşme, SGP hipotezi.

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CHAPTER I: INTRODUCTION

On January 1, 1999 European Economic and Monetary Union (EMU) will be reality and eleven European countries will adopt "euro" as their single currency. The origins of the idea of EMU go back to 1970s. The Delors Report of 1989 formed the basis for the Maastricht Treaty signed in early 1992. This treaty put forth the fundamentals of the economic integration and the convergence criteria to be followed in order to become a member of EMU (Taylor, 1997).

In March 1998, the European Commission presented the "Convergence Report" to the European Council and proposed the membership of eleven countries to the EMU (The European Commission, Convergence Report 1998). Accordingly, in May, the European Council decided that Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Portugal, and Spain would adopt the euro on January 1, 1999 whereas Greece is expected to join two years later, on 1 January 2001. By July 2002, the national currencies of all the participating countries would be fully replaced by euro.

In economics, the replacement of national currencies of several countries by a common currency is often analysed within the framework of "Optimum Currency Area" theory, which was due to the 1961 work of Mundell. In a currency area, the exchange rates of the participating currencies are fixed. The question is then: "what is the appropriate domain of the currency area?" (Mundell, 1961, p.657). Mundell defined the optimal zone for a single currency area as the zone within which labor is willing and able to move freely. McKinnon (1963) later replied to Mundell and argued that the optimal zone is determined by the degree of openness of the economy. According to McKinnon, the word "optimum" is used to define a single currency area in which monetary and fiscal policies together with the external flexible exchange rates can be used to solve the three objectives in the best way: "*i)* the maintenance of full employment, *ii)* the maintanance of balanced international payments, and *iii)* the maintenance of a stable internal average price level" (McKinnon, 1963, p. 717).

Copeland (1994, p.281) defines the monetary union as:

> A single currency zone (or monetary union) is one where the expected means of payment consists of a single, homogeneous currency or of two or more currencies which are linked by an exchange rate which is fixed (at one-for-one) irrevocably.

Therefore, monetary union is more "fixed" than a fixed exchange rate regime because it involves one-for-one fixing and it is irrevocable. The major cost of a monetary union to its participants is the loss of the ability to conduct a national monetary policy.

EMU will require its participants to fix their exchange rates irrevocably by January 1, 1999. However, if there exist persistent differences in monetary policies of the participating countries, it will not be feasible to keep exchange rates fixed for a long time. Hence, EMU will also require a single monetary authority to conduct single monetary and exchange rate policies in euros (Taylor, 1997). This institution will be a union of the national central banks under the name European System of Central Banks (ESCB).

It is obvious that EMU will have significant political and economic consequences. The major problem and a question in many people's minds is that whether Europe will be able to satisfy the criteria of an optimum currency areadespite a lack of sufficient labour mobility, especially in the face of potential exchange rate shocks which have to be dealt with in the absence of exchange rate instrument (Overturf, 1997).

Apart from these concerns, it is widely agreed that euro will play an important role as a stabiliser in international monetary system along with the US dollar and Japanese yen because the economic indicators of the euro zone are comparable to those of the United States and Japan. The population of EMU was 290 million in 1996, whereas United States has a population of 266 million and Japan 126 million. Furthermore, in 1997, the GDP of euro zone was $6,304 billion, while the United States' GDP is $7,819 billion and Japanese GDP is $4,223 billion. In addition, the euro zone has a significant share of world trade: in 1996, the exports of euro zone amounted to $2,067 billion, its imports were $1,859 billion, thus yielding a trade balance of $208 billion. Meanwhile, the United States had exports of $845 billion and imports of $963 billion. In addition, Japanese exports were $457 billion and imports were $432 billion in 1996. As these numbers indicate, euro is likely to challenge US dollar and Japanese yen in international markets (Source: OECD).

There are various expectations from EMU. Some of the member countries expect more benefits than costs while others are suspicious about the future of EMU. It is obvious that among the many benefits of single currency for member countries, low inflation expectations and stable growth can be cited. However, more important than these, euro will eliminate exchange rate risk in terms of trade and investment in EMU. Moreover, larger internal market would increase productivity as well as competitiveness (Özbay, 1997).

After EMU, there will be major changes in the world economic outlook regarding global trade, investment and international finance. One of the major consequences of these issues is real exchange rate determination. Real exchange rate is a key indicator of international competitiveness and economists have long been arguing about the fundamentals behind the fluctuations in real exchange rates. Therefore, determination of the real exchange rate for the new European currency is a crucial step in interpreting the competitiveness of the euro zone against the United States and Japan, the two countries that have major effects on the world economy.

The purpose of this study is to analyse the time series properties of prices and exchange rates of the euro zone. For this purpose, an empirical investigation is carried out. The results indicate that the price indices of the eleven EMU participants have a long-run equilibrium relationship. In addition, almost all nominal bilateral exchange rates and real bilateral exchange rates among these countries are found to be cointegrated for each country. Finally, the PPP hypothesis does not hold for neither of the euro/$, euro/yen or euro/TL real exchange rate indices.

In the next chapter, a brief history of the idea of the economic and monetary union is given along with the recent economic developments in Europe. The third chapter provides an overview of real exchange rates. Chapter four presents definitions of basic concepts used as the tools of the empirical analysis in the remainder of the study. In the fifth, sixth and seventh chapters, the nature of equilibrium relationships among the price levels, bilateral nominal and real exchange rates of the eleven EMU members are investigated. The eighth chapter tests purchasing power parity hypothesis for euro versus US dollar, Japanese yen and Turkish lira. The concluding remarks are given in the ninth chapter.

CHAPTER II: THE HISTORY OF EMU AND THE EUROPEAN ECONOMY

This chapter presents a brief history of the European Economic and Monetary Union (EMU) and recent economic developments in Europe. More detailed historical discussions can be found in Overturf (1997), Taylor (1997), and Jovanovic (1997).

1. The History of EMU

European economic integration began as early as 1950 with the Schuman Plan. At first, the aim was to unite Europe's coal and steel resources. The European Coal and Steel Community (ECSC) was established by the 1951 Treaty of Paris with the participation of France, Germany, Italy, Belgium, the Netherlands, and Luxembourg. A few years later, the Benelux countries proposed to the ECSC the integration of transport and energy in addition to coal and steel. In this respect, the Spaak Committee was established. The Spaak report, which was accepted by the six ECSC countries in 1956, proposed the creation of the common market. This led to the 1957 Treaty of Rome, which established the European Economic Community (EEC) with the same six countries that formed the ECSC. The main purpose of EEC was to rule out internal trade barriers, to levy a common external tariff on manufactured goods, and to establish a common agricultural policy.

In the 1960s, exchange rate policies were questioned and Europe began to discuss a single currency. In 1969, a plan of action for the economic and the monetary union was introduced at the Hague European summit. In 1970, the Werner

Report which proposed three stages for the economic and monetary union was prepared.

The first step after the Werner Report was to establish an exchange rate system which limited exchange rate fluctuations among member countries to bands of ± 2.25 percent around a fixed rate. Besides the six members of the EEC, the UK, Ireland, Denmark, and Norway joined this exchange rate system and the system became to be known as the "snake." However, the snake had difficulties and by 1977 only Germany, Denmark, Norway, Belgium, the Netherlands, and Luxembourg survived in the system.

The EEC continued with its six initial members until the first enlargement on 1 January 1973. The UK, Denmark and Ireland joined the EEC while Norway decided to stay out.

By the late 1970s, it was understood that the monetary union could not be achieved under the policies designated according to the Werner Report due to the 1973 Oil Crisis and the lack of convergence in fiscal policies. Later, with the efforts of France and Germany, the European Monetary System (EMS) was created in 1979, which aimed to have a zone of monetary stability in Europe. This system merely relied on the Exchange Rate Mechanism (ERM), an arrangement of currency stabilisation. The mechanism required the national currencies to float against each other in ± 2.25 percent bands around a central rate. The central rates of each currency against another were calculated by using the values of the currencies against ECU (European Currency Unit), which was created in the early 1970s. In 1980s, ERM served as a mechanism for the countries with relatively weaker currencies to converge to a stable monetary policy and lower inflation by using the strong German mark as an anchor.

In 1985, the "White Paper on Completing of the Single Market" was presented to the European Commission by Lord Cockfield. The paper described the methodology of the plan known as the "1992." The proposal was to remove the trade barriers and the restrictions on the movement of people, capital and goods in the European Community so as to create a single market by the end of 1992. According to the White Paper, the success of the proposed "Single Europe Program" depended on the Single European Act. The Single European Act, which came into effect in 1987, represented a unity of purpose among the European Community States. The White Paper, together with the Single European Act, aimed to remove the physical, technical and fiscal barriers to trade and to complete the single European market by the end of 1992 (Devinney and Hightower, 1991).

The desire for monetary union was not over in Europe. The 1989 Delors Report put forth a three-stage program for the economic and monetary union. First stage of this plan required creating a single financial area, and narrowing the bands in ERM so as to complete the internal market. Stage two consists of closer cooperation in economic policies, establishing a common central bank to coordinate monetary policies, and the transition to locked exchange rates, that is, narrowing the bands in ERM a bit further. In stage three, the common central bank will be turned into an independent European System of Central Banks (ESCB), which will conduct single monetary policy. In addition, the exchange rates will be locked permanently, and a single currency will be introduced. The difference of the Delors Report from the Werner Report is that the Delors Report recommended that the fiscal policies of the participating countries should be in accordance with of the monetary policy conducted by the ESCB instead of requiring centralisation.

In July 1990, the first stage of the Delors Plan was started. The European Council agreed on the Treaty on European Union at Maastricht in December 1991. This treaty was based on the 1989 Delors Report and it put a deadline for the beginning of the third stage: 1 January 1999.

However, the ERM had problems in the beginning of this first stage. Due to the reunification of Germany, the weakening of the US dollar, and the various political and social developments delaying the ratification of the Maastricht Treaty in the EU states, countries with weaker currencies were forced to devalue or to leave the ERM in the late 1992 through mid 1993. As a consequence the bands were widened to ± 15 percent, even wider than the bands before Maastricht. This resolution proved to be successful, and the governments continued their efforts to satisfy the convergence criteria.

The European Monetary Institute (EMI), the predecessor of ESCB, was founded in 1994. This initiated the second stage of EMU. The convergence criteria required by the Maastricht Treaty had to be fulfilled during this second stage. The criteria included price stability; restrictions on fiscal positions, i.e. government net borrowing and government gross debt; exchange rate stability; and interest rate convergence.

The "Convergence Report" of the European Commission presented to the European Council in March 1998 proposed the membership of eleven countries to EMU:

> The Commission, after examining, in its convergence report, the fulfilment by each Member State of the convergence criteria, considers

> that a high degree of sustainable convergence has been achieved in Belgium, Germany, Spain, France, Ireland, Italy, Luxembourg, the Netherlands, Austria, Portugal and Finland; because they are exercising their opt-outs, it is not necessary to assess whether Denmark and the United Kingdom fulfil the other necessary conditions for the adoption of a single currency. On the basis of its report and that of EMI the Commission is recommending to the Council that Belgium, Germany, Spain, France, Ireland, Italy, Luxembourg, the Netherlands, Austria, Portugal and Finland fulfil the conditions for adopting a single currency (European Commission, Convergence Report 1998).

In May 1998, the European Council approved the membership of the eleven countries that were recommended by the Commission and the European Central Bank was established. On 31 December 1998, the conversion rates into euro will be fixed.

2. The European Economy

This section will provide an overview of the European economy. The emphasis will be on the labor market, prices and interest rates. The ERM crises of the early 1990s are also reviewed. Finally, some recent developments will be presented in this section.

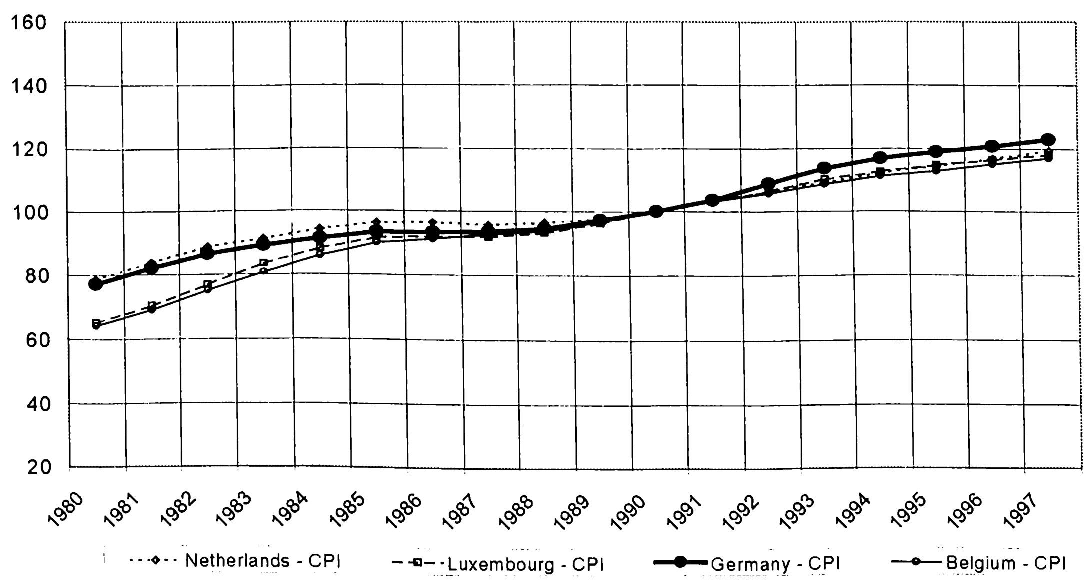
2.1 Prices

The Maastricht Treaty requires price stability of the participating countries. The condition is that for a country to participate in the EMU, over the last year before the beginning of the third stage, its consumer price inflation should not be more than 1.5% above that of the three countries that have the least inflation rates. In this sense, the price levels of the eleven participating countries should be convergent.

Figures 2.1, 2.2 and 2.3 show the CPIs of the ten member states compared with the CPI of Germany, which is the major partner of EMU. In Figure 2.1, the

CPIs of the Benelux countries and Germany are plotted. It is observed that consumer prices in the Benelux countries from 1980 to 1997 go together with the consumer prices in Germany. Consumer prices in the Netherlands went in line with those in Germany during 1980-1990. In the early 1990s, the price indices of the Benelux countries move together. The CPIs of the Mediterranean countries depart from that of Germany especially during the period of 1980-1990. Among those countries, Portugal has the most departing consumer prices. Spanish and Italian consumer prices seem to have the same trend throughout the period.

Figure 2.1 *- The CPIs of the Benelux Countries and Germany for the period: 1980-1990*



Especially after 1990, the consumer prices in Germany, Finland, Ireland, France and Austria exhibited similar patterns. Furthermore, Austrian CPI has always been almost the same as the German CPI.

Figures 2.4, 2.5, 2.6, and 2.7 show the percentage changes in the consumer prices of these countries. These provide a clear picture of the convergence of inflation rates among the EMU states. In Figure 2.4, the percentage changes in the CPIs of Benelux countries are compared with those of Germany. The consumer price inflation in these countries have exhibited similar swings during 1980-1997 and they seem to stabilize around 2% in 1996 and 1997.

***Figure 2.2** - The CPIs of the Meditarrenean Countries and Germany for the period: 1980-1997*

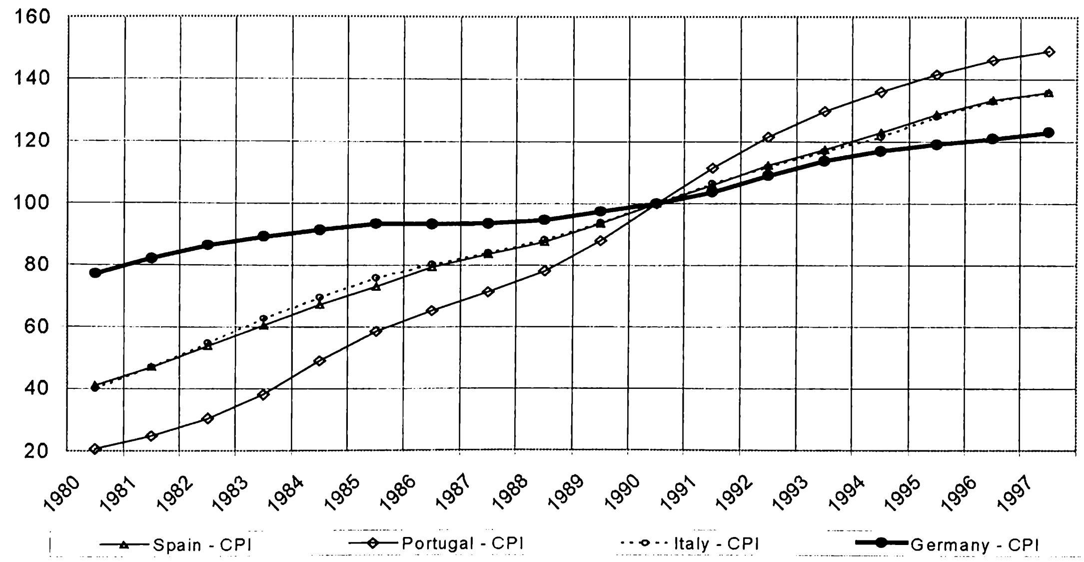
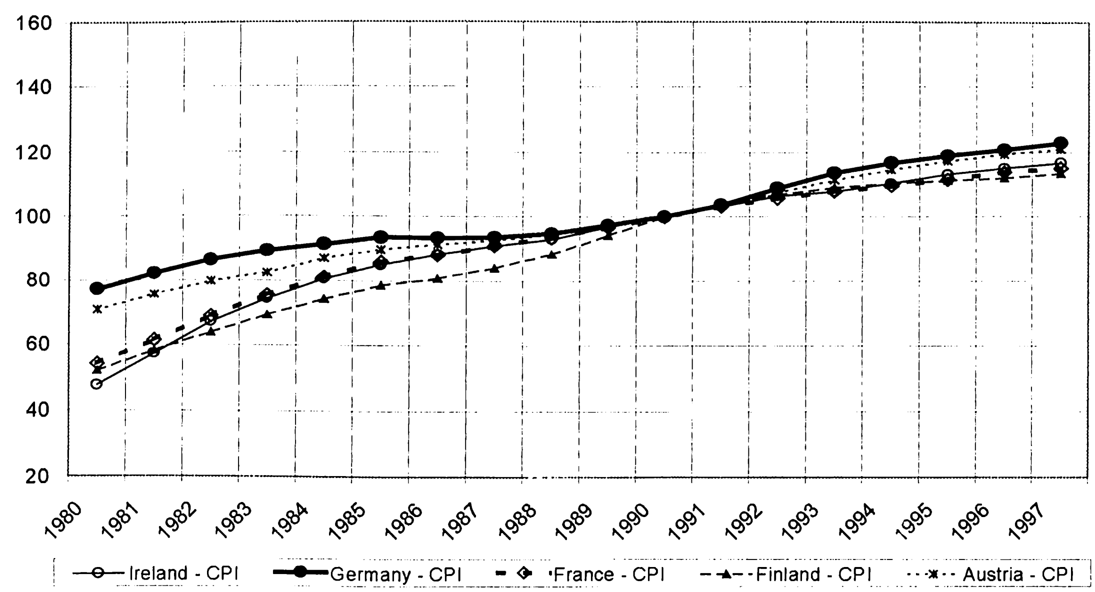


***Figure 2.3** - The CPIs of France, Germany, Finland, Ireland and Austria for the period: 1980-1997*



Similarly, consumer price inflation in Italy and Spain had same cycles while Portugal experienced increasing inflation from 1980 to 1984 (see Figure 2.5). After 1984, the Portuguese consumer price inflation started to decline and eventually converged to those of Italy and Spain. During the 1980s, the Mediterranean countries had inflation rates above the German rate, however, after 1992, their inflation rates reached the German level.

***Figure 2.4** - The Percentage Changes in the CPIs of the Benelux Countries and Germany for the period: 1980-1997*

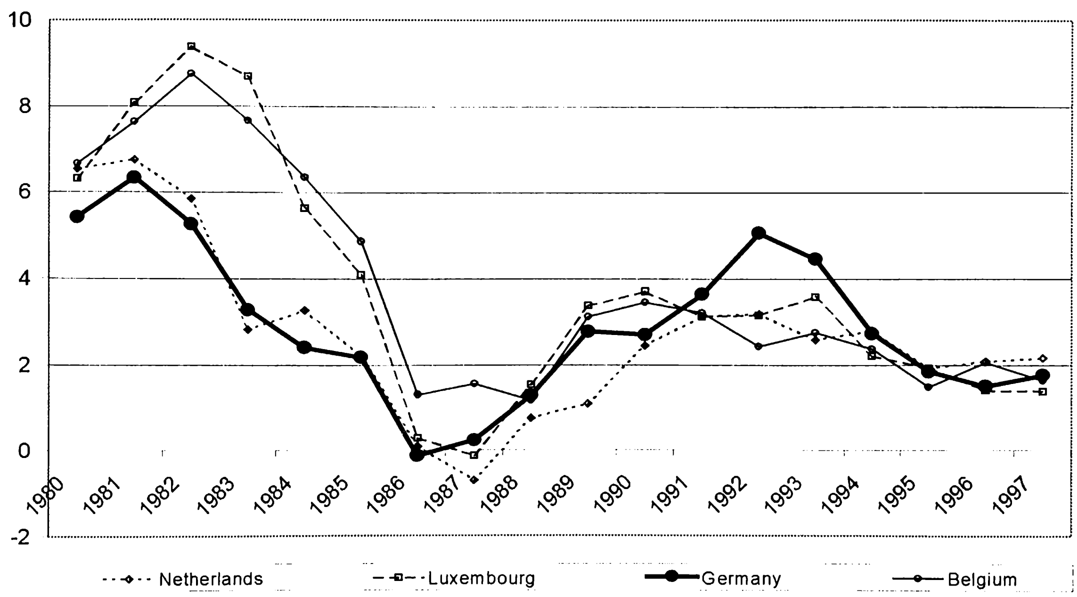


***Figure 2.5** - The Percentage Changes in the CPIs of the Mediterranean Countries and Germany for the period: 1980-1997*

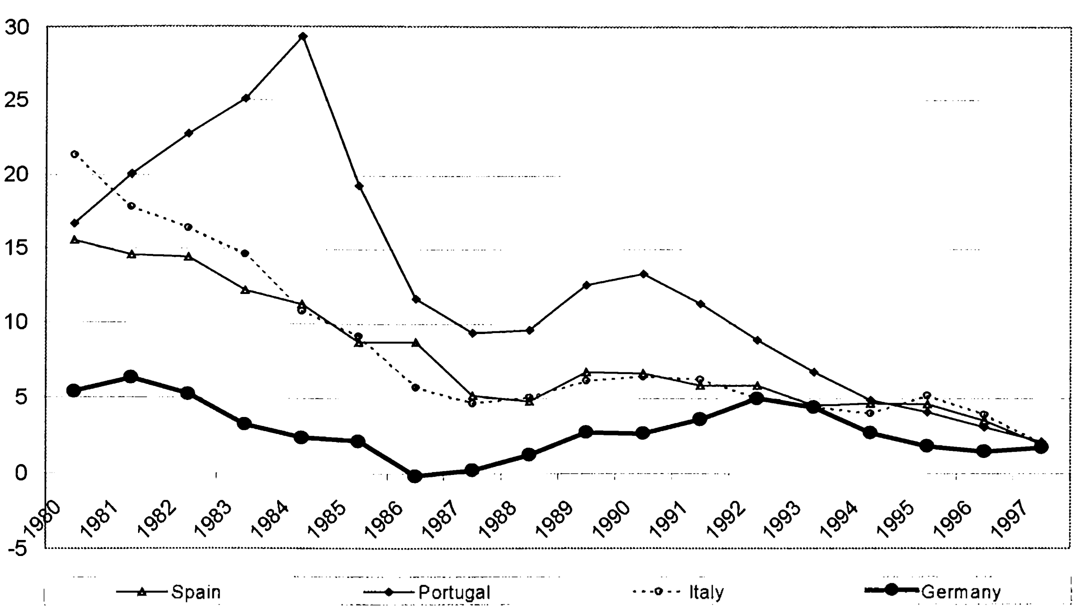


Figure 2.6 depicts the percentage changes in the CPIs of the remaining countries: France, Finland, Ireland, Austria and Germany. In the early 1980s, the change in the consumer prices in Ireland was high relative to the other four

countries. However, together with French and Finnish consumer price inflations, Irish inflation converged to the German level. Austrian consumer price inflation has always moved in line with German rate with some small deviations. It is observed that after 1994, the consumer price inflations in these five countries stabilised around 2%.

***Figure 2.6** - The Percentage Changes in the CPIs of France, Germany, Ireland, Finland, and Austria for the period: 1980-1997*

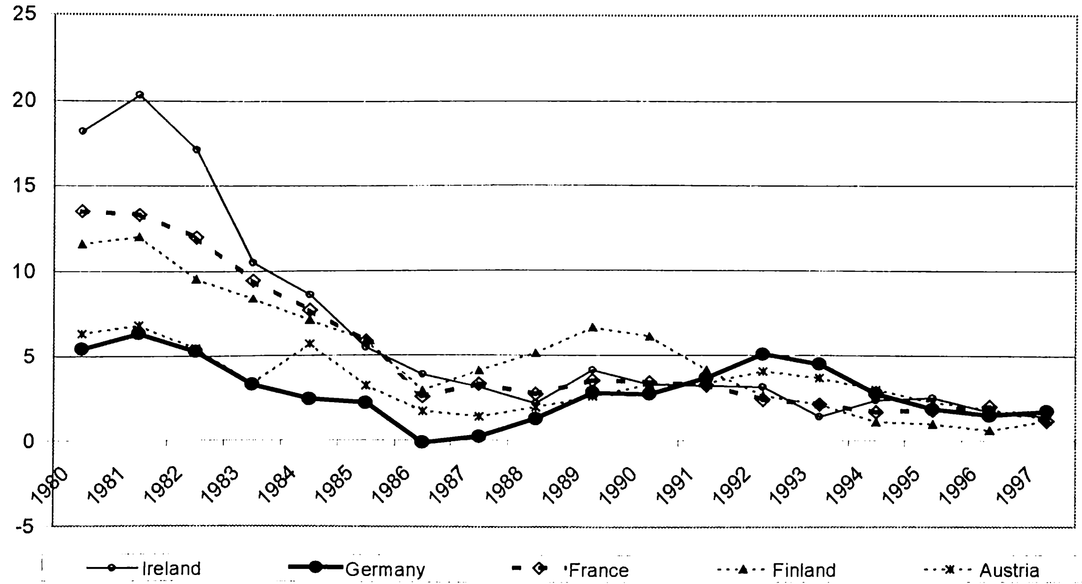
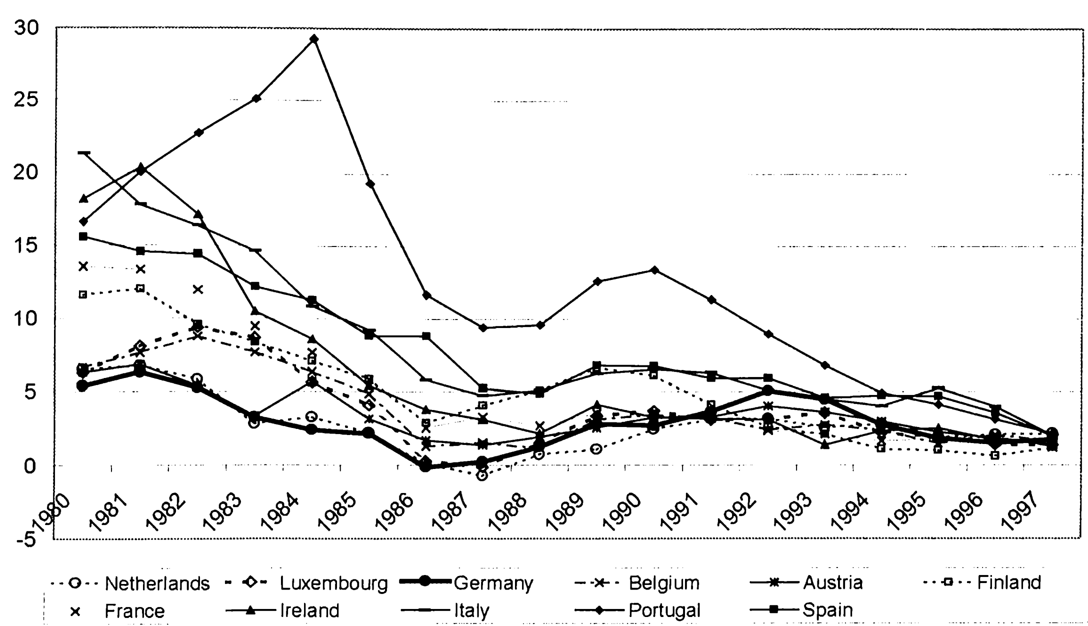


***Figure 2.7** - The Percentage Changes in the CPIs for the period: 1980-1997*



With Figure 2.7, we can compare the inflation levels of the eleven participating countries. Except Portugal, the remaining ten countries have experienced similar cycles in terms of consumer price inflation throughout the period. The Portuguese high inflation of the early 1980s declined in the second half of the 1980s and Portuguese consumer price inflation converge to those of the other European countries in the 1990s. It is also observed from Figure 2.7 that the inflation rates of these eleven countries stabilised around 2% in the last two or three years.

2.2 Interest Rates

The criterion set by the Maastricht Treaty about interest rate convergence puts a restriction on long-term government bonds. The requirement about long-term interest rates is that in the final year of stage two, they cannot be more than 2% points higher than the long-term interest rates of the three countries which have had the least inflation in terms of price stability as explained above.

Figure 2.8 *- Long-term Interest Rates over the period: 1980-1997*

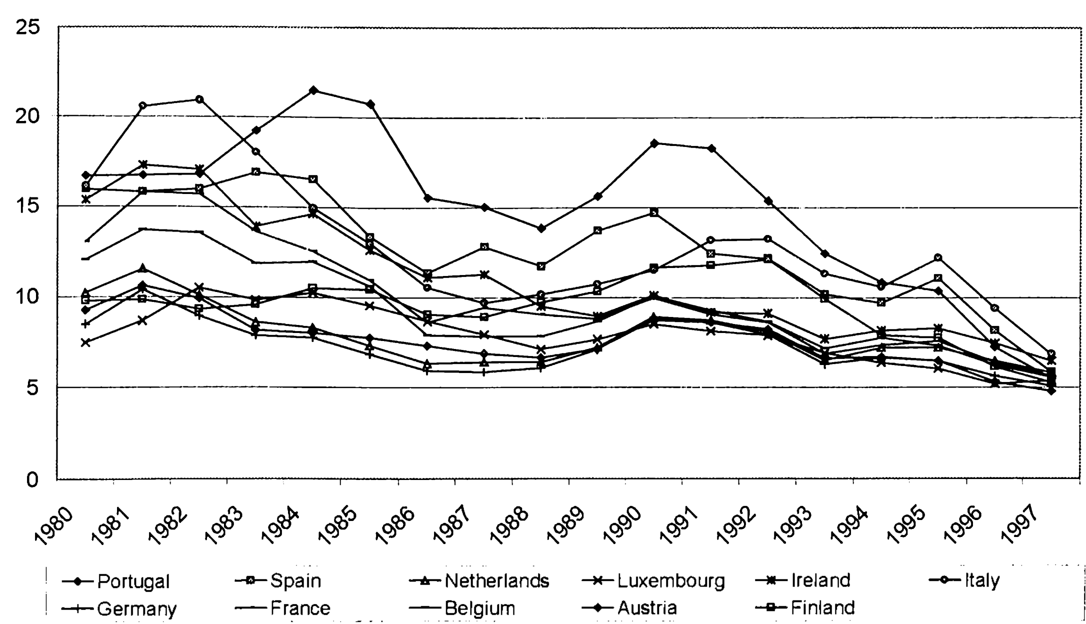


Figure 2.8 summarises the behaviour of the long-term interest rates of the EMU members. As in the case for prices, the three Mediterranean countries had shown a different performance from the other eight countries. However, their rates started to decline after 1995 and converged to the long-term interest rates of the remaining countries. By 1997, the long-term interest rates of the participating states converged and started to fluctuate between 4.8% and 6.8%.

2.3 Labor Market

Labor markets and labor mobility have been a major issue when European economic and monetary union is discussed. This is because of the persistent high unemployment rates the European countries have been experiencing. This section provides an overview of the European labor markets and labor mobility in the European Union. Intra-EU labor mobility is low when compared to the non-EU migrants in the EU States. This might seem to be a major drawback in terms of a monetary union when the theory of optimum currency areas is considered. As it was noted before, Mundell (1961) suggested that the optimum zone of a currency area should be the one in which labor is able and willing to move freely.

In Europe, unemployment rates have been high and the European performance in creating new jobs has been poor (see Table 2.1 below). Since 1957, the European labor force has expanded due to increase in population and women looking for work. In addition, employment structure has changed, there has beem a shift of employment from agriculture to industry. All these factors, together with non-EC migrant labor led to increase in unemployment among the European

Community nationals, especially among the young and women which was long-term in nature (Collins, 1990).

By the 1957 Treaty of Rome, freedom of movement of labor among the EC countries was decided. However, it was not till 1968 that the work permits were abolished and preferences for domestic labor were no longer allowed. This slow progress was due to the fact that the domestic workers feared losing jobs to foreigner and governments feared that countries would export their unemployment. After the first oil crisis, the European Community economies have undergone a recession which gave rise to unemployment (Mayes, 1990).

Table 2.1 *- Labor Force Statistics of EMU States*

	Labor Force 1996 (1,000)	Employment 1996 (1,000)	Unemployment 1996 %
Austria	3,876	3,737	3.6
Belgium	4,297	3,695	12.9
Finland	2,531	2,087	16.1
France	25,613	21,951	12.3
Germany	39,294	35,360	9.0
Ireland	1,494	1,307	11.9
Italy	23,385	20,036	12.0
Luxembourg	218	212	3.3
Netherlands	7,516	6,983	6.5
Portugal	4,885	4,475	7.5
Spain	16,159	12,394	21.9
Total	129,268	112,237	13.2

Source: OECD

As it is seen at the table above, Spain had the highest rate of unemployment in 1996 while Luxembourg had the lowest. Many major European economies experienced two digit unemployment rates such as Belgium, France and Italy. The unemployed in the EMU zone was 13.2% of the total labor force in 1996.

In the 1980s, European unemployment increased substantially and exceeded the OECD average persistently. Furthermore, more than half of the unemployment was long-term in nature. Ljungqvist and Sargent (1998) concluded that this high unemployment in early 1980s is due to Europe's diminished ability to cope with periods of economic turbulence.

In the late 1980s, unemployment problem gained priority in Europe. The underlying reasons of unemployment were considered to be the relatively inflexible labor markets of Europe. The labor markets have responded slowly to shocks and policy changes, and thus, the European efforts to create more jobs turned down (Dent, 1997).

The degree of labor market flexibility, that is, wage flexibility and labor mobility, in addition to facing symmetric demand and supply shocks is very important in determining whether a monetary union is attractive for potential candidates. The theory of optimum currency areas require for participating countries to have high labor market flexibility if they experience divergence in output and employment growth (De Grauwe, 1994).

Labor mobility was an issue which attracts attention of the EMU because as EEC was a common market and a customs union, restricting labor mobility could only prevent efficient resource allocation in Europe (Overturf, 1986). The development of trade patterns will be greatly affected by the degree of factor mobility. If labor mobility is restrained, then wage differential among countries will increase. Therefore, lower-wage countries will have competitive advantage against higher-wage countries for labor-intensive products (Mayes, 1990).

After the Second World War, four phases of labor mobility were observed in Europe. The first one, through 1945-1960, consisted of movements due to the adjustment to the new circumstances after war. The second phase was initiated by labor shortages and lasted from 1955 to 1973. This mainly consisted of the movement of non-EC labor to EC countries, especially France and Germany. The third phase was through 1973-1988 and it involved a restrained migration because of the recessions after the first oil-price crisis. European countries encouraged foreign workers to return home and recruitment of foreign labor was stopped. However, these did not work and the family member of non-EC workers joined them to work in the EC. The fourth phase started after the dissolution of socialism. As a result of economic transition and ethnic wars, people moved to EU from Eastern European countries. In addition to these developments, it is observed that the internal labor mobility in the European Union declined over the period from the 1960s to the late 1980s (Jovanovic, 1997).

The EU countries took measures to enhance internal labor mobility in EU. These include elimination of limits on migration, job information sharing, and social security benefits transfer. These rights of EU workers were quite different from those of non-EU workers. These measures were expected to cause the movement of labor from low to high-wage countries, and thus a decrease in the wage differential. This decrease in the wage differential would lead to a subsequent decline in migration. Actually, these expectations proved to be true. Labor moved especially from Italy to the North to France and West Germany, wage differential declined, and as a result, migration declined (Overturf, 1986).

In 1993, the European Commission has put forth strategies for employment growth which were based on the "White Paper on Growth, Competitiveness and Employment." These required the coordination of policies to create new jobs in Europe. The target was to reduce the unemployment rate in the EU to 5% by creating 15 million jobs by the year 2000. This required an annual employment growth rate of

2% in through 1995-2000. However, only Austria and Luxembourg had unemployment rates below this requirement among the EMU States in 1996 (see Table 2.1). Moreover, six of the eleven EMU members have unemployment levels of more than 10%. European countries need to improve both the employer's and the employee's ability to create jobs. In addition, education and training should be more emphasised (Dent, 1997).

2.4 EMS in the Early 1990s

On December 10, 1991, the Maastricht Treaty on European Union was agreed by the heads of the governments of the European Union States. The main point of the Treaty was that it announced a single monetary zone for Europe. To achieve that single monetary zone, some degree of economic convergence must be established, and the criteria of this convergence were also set by the Maastricht Treaty. Among the countries which signed the Treaty, Denmark and Ireland had to hold referanda due to constitutional requirements.

The Danish government decided to hold the referandum on 2 June 1992. However, because of the fears of losing national identity and control over the Danish krone, and having no confidence in political leadership, Danes voted "No" for the Maastricht Treaty. This was a shock which led to arising doubts about EMU and troubles in the ERM (Overturf 1997, Pitchford et. al. 1997).

After the Danish rejection, French president decided to hold a referandum in September. After the Irish voted in favor of the Treaty in June, French did so in September.

In the meantime, there were troubles in the ERM. Portuguese escudo entered the mechanism in April 1992. The crises in the ERM started in September 1992 with the collapse of the Finnish markka under speculative selling. In fact, Finland was not a member of either of the ERM or the EMS or even the European Union at that time, but was voluntarily peggingthe markka to the ERM. At the same time, Sweden raised interest rates as a result of a similar event although it was not in the system. The Swedish government was able to maintain its peg with that increase in interest rates. However,Sweden finally had to abandon pegging in November, after further troubles in the ERM.

On September 13th, Italian government devalued the liraand Germany reduced interest rates as a result of an agreement. The realignment of lira was 7%, which was below what was thought to be necessary to correct the inflation differential of several years and the subsequent exchange rate misalignment.

These developments led to a big crisis in the ERM on 16 September 1992, known as the "Black Wednesday." British pound, Italian lira and Spanish peseta came under speculative attacks and were forced below the floors of ERM bands because they were considered overvalued. Both British pound and Italian lira dropped out from the ERM. Spanish peseta could stay in with a 5% devaluation. Ireland, Spain, and Portugal imposed exchange controls temporarily (Overturf 1997, Pitchford et. al. 1997).

After the drop out by Swedish krona in November, Portugal and Spain devalued their currencies by 6%. Denmark, France and Ireland were next to come. By Bundesbank support, French franc survived.

On 1 January 1993, the single European market started and exchange rate controls in Ireland, Spain and Portugal were removed. Then, Ireland raised interest rates and devalued by 10%. In the meantime, Danish Central Bank intervened to maintain the krone's peg to the ERM.

In July 1993, there was a huge selling of the French franc against German mark. This time Bundesbank intervention was not enough to save the franc from falling below the floor of ERM bands. After an emergency meeting, finance ministers and central bankers decided to widen the bands of the ERM to ±15 % except for the German mark - Dutch guilder bands which remained as ±2.25 %.

As a result of the crises in the ERM, bands were widened. Wider bands helped the continuation of official participation in the EMS, let the countries show the credibility of their commitment and allowed for an easier transition by leaving room for a realignment towards the third stage. Finally, there was more uncertainity in the speculative process because of wider bands, and stability was restored in the markets (Overturf, 1997).

In the meantime, the Danes were given another chance to vote. The second referandum was held in May 1993. This time, they voted for the Maastricht Treaty. The second stage of EMU started on 1 January 1994 after the ratification of the Treaty by the German Constitutional Court in November 1993 which was the last to raitfy among the European Union States.

In the first stage, Europe faced many developments which resulted in stepping back fron the EMU by European citizens. these include the breakup of Soviet Union, the reunification of Germany, the increased nationalistic feelings in Europe, the rapid shift of former Soviet States towards capitalistic economies, the distrust in politics and politicians, the war in Bosnia, economic uncertainity and unemployment.

2.5 The Recent Developments

The European Commission announced the method for determining the irrevocable conversion rates for the euro on 2 May 1998 (European Union, 1998). According to the announced method, the ERM bilateral central rates of the participating currencies as of May 1998 will be used to calculate the conversion rates. It will be the responsibility of the central banks of the member countries to ensure that the market exchange rates on 31 December 1998 will satisfy the central ERM rates of May 1998 (see Table 2.1). On 1 January 1999, the irrevocable conversion rates will be adopted as the third stage begins.

In addition to these developments, ECU will be replaced by euro one-for-one on 1 January 1999 in every legal instrument involving euro. This requires the conversion rates for euro be equal to the official value of ECU as of 31 December 1998.

One difficulty arises in this context: ECU includes British pound, Danish krone, and Greek drachma. Therefore, it is possible to fix bilateral rates of the currencies of the eleven EMU countries before the end of 1998, but it is not possible to announce the irrevocable rates at which the participating currencies will be converted into euro. Therefore, 1 January 1999 can be taken as the beginning of EMU. In addition to these initial countries, Greece is expected to join the euro zone two years later, on 1 January 2001. Euro notes and coins will be introduced on 1 January 2002, three years after the beginning of the third stage. Only six months after, national notes and coins will be abandoned and euro will be the only legal tender in the EMU states.

***Table 2.2** - ERM Bilateral Central Rates to be Used in Determining the Irrevocable Conversion Rates for the Euro.*

	DEM 100=	BF/ LF 100=	ESP 100=	FRF 100=	IEP 1=	ITL 1000=	NLG 100=	ATS 100=	PTE 100=	FIM 100=
DEM	-									
BF/LF	2062.55									
ESP	8507.22	412.462								
FRF	335.386	16.26	3.94							
IEP	40.27	1.95	0.47	12.01						
ITL	99000.2	4799.90	1163.72	29518.3	2458.56					
NLG	112.67	5.46	1.32	33.60	2.80	1.14				
ATS	703.55	34.11	8.27	209.77	17.47	7.11	624.42			
PTE	10250.5	496.98	120.49	3056.34	254.56	103.54	9097.53	1456.97		
FIM	304.00	14.74	3.57	90.64	7.55	3.07	269.81	43.21	2.97	-

Source: The European Commission (The numbers are rounded up to two decimal places).

CHAPTER III: REAL EXCHANGE RATES: AN OVERVIEW

Among the various theories of real exchange rate determination, the Purchasing Power Parity (PPP) approach is the most common. Zietz (1996) defines the PPP form of real exchange rate as the nominal exchange rate multiplied by a ratio of a domestic price index to a foreign price index. The basic assumption of the PPP approach is that equilibrium real exchange rates remain constant over time, and thus, relative price differences between countries are offset by the movements in nominal exchange rates.

There are three versions of this approach. The first one is called the "Law of One Price" and it says that the real exchange rate can be calculated by assuming that the price of a good denominated in home currency is equal to the price of the same good denominated in foreign currency. To illustrate, let the price of "A" be TL750,000 in Turkey and $3 in the US. Then, according to the law of one price, the real exchange rate is 250,000 TL/$. But, the shortcoming of this approach is that, in order to make such a comparison between prices in terms of different currencies, the good in question should be identical in both countries. The law of one price also assumes no transaction costs and no trade barriers, which are not very realistic (Clark et.al., 1994).

Second version of the PPP approach is the Absolute PPP hypothesis. Under the same assumptions as the law of one price (no transaction costs, no trade barriers and homogeneity of goods across two countries), absolute PPP defines the real exchange rate by the help of the condition that the price of one basket of goods and services denominated in domestic currency is equal to the price of that identical basket denominated in foreign currency (Clark, et. al., 1994).

Relative PPP hypothesis is the third version of the PPP theory. The basic assumption is that the percentage changes in the nominal bilateral exchange rate are equal to the differences between the inflation rates of two countries. The relative PPP hypothesis states that one country's inflation rate can only be higher than another's to the extent that its exchange rate depreciates (Copeland, 1994).

Some other major theories of the real exchange rate determination are the Balance of Payments Approach, the Macroeconomic Balance Approach, the Relative Price of Tradables and Non-tradables, the Monetary Approach and the Asset Market View.

While there are large deviations from purchasing power parity in the short-run, there is evidence that the real exchange rates eventually converge to PPP in the long-run. Edwards (1988) defines the sustained deviation of the short-run real exchange rate from its long-run equilibrium level (PPP) as the "real exchange rate misalignment."

The large deviations from PPP can be attributable to three main factors: *i)* changes in the terms of trade (TOT) because of changes in trade patterns, *ii)* changes in the relative price of home and traded goods because of economic growth, and *iii)* deviations in real price ratios because of monetary and exchange rate changes, imperfectly fixed wages and prices (Dornbusch, 1988). This issue is crucial in the sense that small deviations from PPP can cause large changes in trade flows which in turn induce external competitiveness. In addition to these effects, real depreciation increases inflation while real appreciation reduces.

To clarify the issue, we can adopt Dornbusch's (1988) definition of the real exchange rate:

$$r = \frac{p_d}{e.p_f} \tag{3.1}$$

where r is the real exchange rate, p_d and p_f denote the domestic and foreign price levels respectively, and the nominal bilateral exchange rate between the two countries in question is denoted by e. According to this definition, an increase in r indicates a real appreciation whereas a decrease in r indicates a real depreciation.

Dornbusch (1976) developed a model about exchange rate determination which emphasises sticky prices in product and labor markets. The importance of the model is the assumption that product markets adjust slowly but financial markets adjust instantaneously. This means that financial markets should over-adjust in response to shocks in order to compensate the stickiness of the prices in the goods markets. For example, when nominal money stock increases, real money stock will increase as a consequence since prices are sticky. In order for money market to clear, domestic nominal interest rate should decrease, so that the demand for real balances is equal to the supply of real balances. The decrease in domestic interest rate would cause a real depreciation in the short-run. But this decrease in interest rate below world levels can only be temporary, because when prices increase later as a result of increased aggregate demand, the real money stock will decrease back to its original level. Therefore, interest rates will increase, demand for real balances will decrease and aggregate demand will decrease. The real exchange rate will be back at its original level while the nominal exchange rate will be at a new level (it will appreciate here).

When a real disturbance occurs, the overshooting phenomenon can be seen as a result of the over-adjustment of the real exchange rate, which has damaging consequences for the economy. In Dornbusch's model, the exchange rate is in equilibrium only in the long-run, because in the short-run, sticky prices make exchange rate deviate from its equilibrium level. Dornbusch argues that when the exchange rate is above its long-run equilibrium level (overvalued), it will be expected that it will depreciate in the future rather than appreciate.

If a country's real exchange rate is overvalued, this will be followed by an undervaluation. After the initial overvaluation, the international competitiveness of the country would worsen; thus, capital would be reallocated from tradables sector to non-tradables sector. Price of non-tradables would decrease because the cost of producing them had decreased. Therefore, there should be a depreciation before the real exchange rate converges to its long-run equilibrium level.

Therefore, real exchange rate provides an index of competitiveness and is crucial in a customs union. For example, a large real appreciation of the currency of a country engaged in a custom's union will cause a large decline in the competitiveness of a country. This will induce the government to levy tariffs or to put non-tariff barriers. However, the main aim of a custom's union is to remove internal tariff and non-tariff barriers. Thus, a custom's union requires real exchange rate stability among its members (Artis, 1990).

CHAPTER IV: UNIT ROOTS, INTEGRATION AND COINTEGRATION: BASIC DEFINITIONS AND CONCEPTS

Most macroeconomic variables have stochastic and deterministic trends. The stochastic components are modelled as integrated processes. While the stochastic trends of real variables can be remedied by I(*1*) models, those of nominal variables usually require I(2) modelling, they are not stationary even after first differencing (Jorgensen, Kongsted, and Rahbek, 1996). In addition, the existence of a stationary combination of non-stationary variables is required by equilibrium theories involving them.

A stationary series exhibits mean reversion, that is, it will converge to its unconditional mean. In addition, it has a finite, time-invariant variance and a correlogram that dies out as the lag length increases (Enders, 1995).

The correlogram of a unit root process will diminish very slowly, its variance is time-dependent and becomes infinite as time goes to infinity. A unit root process does not have a value to which it will converge in the long-run (Enders, 1995).

This issue is very important since almost all macroeconomic variables have non-stationary components. The major tests for the presence of a unit root are Dickey-Fuller and Phillips-Perron tests. Either differencing or detrending is used to make a non-stationary series stationary.

Engle and Granger (1987, p. 252) define integration as:

> A series with no deterministic component which has a stationary, invertible, ARMA representation after differencing d times, is said to be integrated of order d, denoted $x_t \sim \mathrm{I}(d)$.

The sum of an I(*0*) series and an I(*1*) series is I(*1*). In addition, if $z_t \sim$ I(d) then $a + bz_t$ is also I(d), where a and b are constants, $b \neq 0$. Similarly, when z_t and y_t are both integrated of order d, a linear combination of these two, say x_t, is again I(d) in general. However, there are special cases that $x_t \sim$ I(d-b) where b is a positive integer.

This yields the definition of cointegration: the I(d) process x_t is called cointegrated of order d, b [CI(d,b)] if $\beta' x_t$ is I(d-b) where β is called the cointegrating vector, $\beta \neq 0$; $b=1,\ldots,d$; $d=1,\ldots$ (Johansen, 1995).

The interpretation is as follows: assume $d=b=1$. This means that x_t is I(*1*) but $\beta' x_t$ (the equilibrium error) is I(*0*). Therefore, equilibrium would occur, $\beta' x_t$ would wander around its mean. However, if x_t is not cointegrated, we cannot talk about an equilibrium relationship and $\beta' x_t$ would rarely be around its mean.

There can be more than one cointegrating vector. In fact, the number of linearly independent cointegrating vectors is equal to r, the rank of (pxr) β matrix, where p is the number of components in x_t. r is called the "cointegrating rank" of x_t (Engle and Granger, 1987).

CHAPTER V: DO PRICES MOVE TOGETHER IN THE LONG-RUN?

This chapter concentrates on determining whether there exists a long-run relationship among the prices of eleven EMU countries. For this purpose, cointegration analysis of the price indices of the eleven countries is used.

Table 5.1 *- Inflation rates of participating states..*

	1997 Inflation (%)	1998 Inflation (%)
Austria	1.1	1.5
Belgium	1.4	1.3
Finland	1.3	2.0
France	1.2	1.0
Germany	1.4	1.7
Ireland	1.2	3.3
Italy	1.8	2.1
Luxembourg	1.4	1.6
Netherlands	1.8	2.3
Portugal	1.8	2.2
Spain	1.8	2.2
MAASTRICHT CRITERIA	**3.2**	**3.2**

Source: The Economist

For a monetary union to be successful, the economies of the member countries should be similar in structure and should exhibit resembling cycles in addition to having factor mobility and similar transmission mechanisms of the single monetary policy conducted by the single monetary authority. Although the recent inflation rates of the member states appear to be under the level set by the Maastricht Treaty (see Table 5.1), this does not assure that the resulting relationship among prices are permanent. However, we can adopt cointegration analysis which allows testing the presence of linear long-run equilibrium relationships in order to understand whether there exists a permanent convergence.[1]

In the next section, the statistical model used in the analysis will be explained. The empirical model for eleven price indices and the estimation results will be provided in the subsequent sections.

1. The Statistical Model:

The p-dimensional autoregressive process x_t is defined as:

$$x_t = \Pi_1 \cdot x_{t-1} + \Pi_2 x_{t-2} + \ldots + \Pi_k x_{t-k} + \Phi D_t + \varepsilon_t \qquad t=1,\ldots,T \qquad (5.1)$$

for fixed $x_{-k+1},\ldots,x_0$ with ε_t being independent and identically distributed (iid) as $N_p(0,\Omega)$. D_t is a term that includes any non-stochastic regressors such as seasonal or intervention dummies, constant or linear term. Π_i and Φ are the coefficients (Johansen, 1995).

The model reformulated as error correction form where x_t is an $I(1)$ process can be written as:

$$\Delta x_t = \Gamma_1 \cdot \Delta x_{t-1} + \ldots + \Gamma_{k-1} \cdot \Delta x_{t-k-1} + \Pi \cdot x_{t-1} + \mu + \Phi \cdot D_t + \varepsilon_t \qquad (5.2)$$

$t=1,\ldots,T$

The cointegration hypothesis is:

$$H_1(r): \Pi = \alpha\beta' \qquad (5.3)$$

where α and β are pxr matrices. This is the hypothesis of at most r cointegrating vectors where r is the rank of Π. (Hansen and Juselius, 1995; Johansen, 1995).

The I(2) model for p-dimensional VAR is given by:

[1] The current econometric practice allows to estimate only the linear long-run equilibrium relationships (Enders, 1995).

$$\Delta^2 x_t = \Pi \cdot x_{t-1} - \Gamma \cdot \Delta x_{t-1} + \sum_{i=1}^{k-2} \Psi_i \cdot \Delta^2 x_{t-i} + \Phi \cdot D_t + \varepsilon_t \qquad (5.4)$$

t=1,…T

where ε_t is iid Normal. A simpler notation for (5.4) is:

$$\Delta^2 x_t = \Pi \cdot x_{t-1} - \Gamma \cdot \Delta x_{t-1} + \Psi z_t + \varepsilon_t \qquad t=1,\ldots,T \qquad (5.5)$$

where $z_t' = (\Delta^2 x_{t-1}', \ldots, \Delta^2 x_{t-k+2}', D_t')$ (Johansen, 1995).

In I(2) models, there are two reduced rank conditions:

i. $\Pi = \alpha \cdot \beta'$ where α and β are pxr matrices, $r<p$.

ii. $\alpha_\perp' \cdot \Gamma \cdot \beta_\perp = \xi \cdot \eta'$ where ξ and η are $(p-r)xs$, $s \leq p-r$

Further details and statistical derivations are beyond the scope of this study and will be omitted. Johansen (1991 and 1995), and Hansen and Juselius (1995) give detailed discussions on I(*1*) models while Johansen (1995), Paruolo (1996), Jorgensen, Kongsted and Rahbek (1996), and Juselius (1997) analyse I(2) models.

2. The Tests for Determining the Cointegrating Rank

The tests used to determine the cointegrating rank depend on the significance of the characteristic roots of Π. The rank of a matrix is defined as the number of its characteristic roots that are different from zero. If all the roots are zero, then r=0, and the process is not cointegrated. For a p-dimensional process Π is a pxp matrix, and therefore has p characteristic roots.

The λ_{max} and λ_{trace} test statistics are used to determine the cointegrating rank. As a first step, the p characteristic roots of the Π matrix are ordered such that $\lambda_1 > \lambda_2 > \ldots > \lambda_p$. Note that, for stability, the necessary and sufficient condition is that all characteristic roots lie inside the unit circle. If all roots are zero, then $ln(1-\lambda_i)=0$ for $i=1, \ldots, p$ since $ln(1)=0$, and the variables are not cointegrated. If $r=1$, then the largest root will be $0<\lambda_1<1$ and all the other roots will be zero.

Secondly, using the estimated Π matrix and its characteristic roots, two test statistics are calculated:

$$\lambda_{trace}(r) = -T\sum_{i=r+1}^{p} ln(1-\hat{\lambda}_i) \tag{5.6}$$

$$\lambda_{max}(r,r+1) = -T\, ln(1-\hat{\lambda}_{r+1}) \tag{5.7}$$

where T is the number of observations and $\hat{\lambda}_i$ are the eigenvalues of Π. The critical values of λ_{max} and λ_{trace} were calculated by Johansen and Juselius (1990).

The trace test is used to test the null of rank(Π)$\leq r$ while λ_{max} is used to test the null of rank(Π)$=r$ against the alternative of rank(Π)$=r+1$.

3. The Empirical Model

The data vector x_t in this analysis consists of the natural logarithms of the price indices of the eleven countries with base year 1990 for the period 1980:1-1997:12 where:[2]

p_1: CPI of Austria

p_2: CPI of Belgium

p_3: CPI of Finland

p_4: CPI of France

p_5: CPI of Germany

[2] See Appendix A for details.

IBM (International Business Machines)
Türk Limited Şirketi
Büyükdere Caddesi, Levent, 80613 İstanbul
Tel: (212) 280 09 00 Fax: (212) 278 04 37

p_6: PPI of Ireland

p_7: CPI of Italy

p_8: CPI of Luxembourg

p_9: CPI of the Netherlands

p_{10}: CPI of Portugal

p_{11}: CPI of Spain

The price series are close to I(1) and therefore, an I(1) model is adopted for the analysis. All estimates are based on the two step procedure of Johansen (1995). The calculations are made using the computer package CATS for RATS (Hansen and Juselius, 1995).

3.1 Estimation Results

The estimates of λ_{max} and λ_{trace} statistics are provided in table 5.2. According to these results, the calculated λ_{max} statistics allow to reject the null hypotheses of r=0 against the alternative of r=1; r=1 against the alternative of r=2; r=2 against the alternative of r=3; and so on until the null of r=9 is rejected against r=10. However, it is not possible to reject H_o: r=10 against the alternative of r=11 at any conventional significance level.

Furthermore, λ_{trace} statistics calculated indicate similar results. The null hypothesis of r=10 against the general alternative cannot be rejected at 1%, 5%, and 10% levels of significance. These results lead us to determine the cointegrating rank as 10, that is, there exist 10 distinct cointegrating vectors.

Ankara Şubesi: Cinnah Caddesi 3, Kavaklıdere, 06680
Tel: (312) 427 81 45 Fax: (312) 426 72 30
Ticaret Sicili: 82821/26108 Sermayesi 6.000.000.000.-TL.

***Table 5.2** - The test statistics calculated for respective values of r under the null hypothesis*

H_o	λ_{max}	λ_{trace}
r=0	192.85	878.40
r=1	163.16	685.55
r=2	131.96	522.39
r=3	100.91	390.43
r=4	86.03	289.52
r=5	64.53	203.49
r=6	48.27	138.96
r=7	42.37	90.70
r=8	28.80	48.33
r=9	18.67	19.53
r=10	0.86	0.86

3.2 Can any of the prices be excluded?

The analysis of whether any of the price indices can be excluded from the long-run analysis is given by:

$$H_o : \beta_{ij} = 0,\ j=1, \ldots, r. \qquad (5.8)$$

The test statistic is asymptotically distributed as χ^2 with r degrees of freedom (Hansen and Juselius, 1995). For r=10, the critical χ^2 value is 15.98, 18.31 and 23.21 at 10%, 5% and 1% level of significance respectively. The results indicate that it is not possible to exclude any of the price indices from the lung-run analysis (see Table 5.3).

Table 5.3 - χ^2 statistics calculated for the eleven price indices for the test of long-run exclusion

Prices	χ^2
lnp_1	101.19
lnp_2	168.35
lnp_3	103.20
lnp_4	119.82
lnp_5	210.86
lnp_6	118.52
lnp_7	153.07
lnp_8	162.92
lnp_9	104.00
lnp_{10}	112.00
lnp_{11}	170.05

4. Conclusion

The empirical results of this chapter indicate that there exists a linear long-run equilibrium relationship among the prices of the eleven countries participating in the EMU.

The data was found to be I(*1*) prior to the analysis, and thus the model is adopted accordingly. Based on the sample period of 1980:1-1997:12, we can conclude that there exists a cointegrating relationship among the prices. In addition, λ_{max} and λ_{trace} tests indicated the presence of 10 distinct cointegrating vectors. Moreover, it is found that none of the price indices can be excluded from this long-run relationship.

Therefore, it is possible to say that the prices of the eleven EMU participants move together in the long-run. This implies that the price indices are convergent as required by the Maastricht Treaty.

CHAPTER VI: AN ANALYSIS OF NOMINAL EXCHANGE RATES FOR ELEVEN EMU COUNTRIES

Since 1979, there exists an arrangement of currency stabilisation among European countries known as the Exchange Rate Mechanism (ERM). The purpose of ERM is to keep participating currencies trading without large fluctuations. Therefore, most of the European currencies are not allowed to fluctuate freely against each other. In addition, Belgium and Luxembourg already have a monetary union; their currencies are fixed one-for-one.

The Maastricht Treaty required exchange rate stability as a criterion to participate in the EMU. According to this criterion, the currencies of the potential EMU countries must participate in the ERM at least two years before the beginning of the third stage. This requirement is to prevent the candidates devalue at their own initiative to gain competitiveness in the expense of others.

Thus, it is expected that the bilateral nominal exchange rates of the eleven participating countries move together in the long-run. This chapter adopts the cointegration analysis similar to the one used in the previous chapter for each of the EMU members to test whether its bilateral nominal exchange rates with the remaining nine countries[3] have a long-run equilibrium relationship.

[3] Since Belgium and Luxembourg have a monetary union, they are counted as a single country here.

1. The Statistical Model and the Tests for Determining the Cointegrating Rank:

As expressed above, the statistical model used in this chapter is the same as the model described in section 5.1, equation 5.1 as the definition of the VAR model; equations 5.2 and 5.3 as the I(*1*) model; and equations 5.4 and 5.5 as the I(*2*) model. Similarly, the tests explained in section 5.2, λ_{max} and λ_{trace}, will be adopted in this chapter.

2. Estimation Results:

For each of the ten countries, the bilateral nominal exchange rates[4] are analysed. The results are summarised below. The data vector consists of the bilateral nominal exchange rates of Austria, Belgium and Luxembourg, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal and Spain against each other.

2.1 Austria

Depending on the results of prior tests, a model with intercept and trend in the cointegrating relations is adopted.

According to the estimated output, the calculated λ_{max} and λ_{trace} statistics indicate that the cointegrating rank *r* is 8 (see Table 6.1). We can reject the null hypotheses of r=0 against the alternative of r=1; r=1 against the alternative of r=2; till the null of r=7 is rejected against r=8 by examining the λ_{max} statistics. It is not possible to reject H_0: r=8 against the alternative of r=9 at any conventional significance level.

[4] See Appendix A for details.

In addition, λ_{trace} statistics calculated indicate similar results. The null hypothesis of r=8 against r≠8 cannot be rejected at 1%, 5%, and 10% levels of significance. Therefore, we can conclude that there are 8 distinct cointegrating vectors.

Table 6.1 *- The test statistics calculated for respective values of r under the null hypothesis for the Austrian data*

H_o	λ_{max}	λ_{trace}
r=0	166.30	600.76
r=1	146.15	434.46
r=2	84.12	288.31
r=3	57.63	204.19
r=4	49.29	146.56
r=5	43.23	97.26
r=6	26.72	54.03
r=7	17.89	27.31
r=8	9.42	9.42

The results for the test of long-run exclusion (see equation 5.8) indicate that it is not possible to exclude any of the variables from the long-run analysis. The critical χ^2 values with 8 degrees of freedom are 20.09 for 1%, 15.51 for 5%, and 13.36 for 10% levels of significance. The calculated χ^2 values are given in Table 6.2 below.

Table 6.2 *- χ^2 statistics calculated for the nine nominal exchange rate indices of Austria for the test of long-run exclusion*

Exch. Rates	χ^2
Aus. Schilling/Bel.&Lux. Franc	111.37
Aus. Schilling/Fin. Markka	48.04
Aus. Schilling/Fra. Franc	106.74
Aus. Schilling/Ger. Mark	79.77
Aus. Schilling/Ire. Pound	87.99
Aus. Schilling/Ita. Lira	58.38
Aus. Schilling/Net. Guilder	98.67
Aus. Schilling/Por. Escudo	53.96
Aus. Schilling/Spa. Peseta	48

Therefore, it is possible to conclude that nine nominal bilateral exchange rates for Austria has a linear equilibrium relationship in the long-run and it is not possible to exclude any of them from the analysis.

2.2 Belgium and Luxembourg

Similar results are found for Belgium and Luxembourg. Both λ_{max} and λ_{trace} tests indicate that the cointegrating rank is 8. Moreover, it is not possible to exclude any of the exchange rate indices from the long-run relationship. These results are summarised in tables 6.3 and 6.4.

Table 6.3 *- The test statistics calculated for respective values of r under the null hypothesis for the Belgium-Luxembourg data*

H_o	λ_{max}	λ_{trace}
r=0	123.83	445.39
r=1	85.66	321.86
r=2	72.14	236.20
r=3	56.16	164.06
r=4	40.48	107.09
r=5	36.28	67.42
r=6	19.78	31.14
r=7	10.78	11.35
r=8	0.58	0.58

According to the tests done prior to the analysis, an I(*1*) model without any deterministic components is adopted for Belgium-Luxembourg.

Table 6.4 *- χ^2 statistics calculated for the nine nominal exchange rate indices of Belgium-Luxembourg for the test of long-run exclusion*

Exch. Rates	χ^2
Bel.&Lux. Franc/Aus. Schilling	54.87
Bel.&Lux. Franc/Fin. Markka	40.39
Bel.&Lux. Franc/Fra. Franc	82.57
Bel.&Lux. Franc/Ger. Mark	45.28
Bel.&Lux. Franc/Ire. Pound	57.39
Bel.&Lux. Franc/Ita. Lira	37.02
Bel.&Lux. Franc/Net. Guilder	89.84
Bel.&Lux. Franc/Por. Escudo	59.99
Bel.&Lux. Franc/Spa. Peseta	46

The critical χ^2 values with 8 degrees of freedom are 20.09 for 1%, 15.51 for 5%, and 13.36 for 10% levels of significance.

2.3 Finland

Prior testing indicates a model similar to the one adopted for Austria in section 2.1: an I(*1*) model which includes a constant and a trend term in the cointegrating relationships.

***Table 6.5** - The test statistics calculated for respective values of r under the null hypothesis for the Finnish data*

H_o	λ_{max}	λ_{trace}
r=0	140.45	522.12
r=1	135.17	411.66
r=2	68.95	276.49
r=3	60.04	207.54
r=4	48.27	147.50
r=5	41.45	99.22
r=6	31.84	57.77
r=7	16.98	25.93
r=8	8.95	8.95

Table 6.5 above presents the estimation results for the nominal bilateral exchange rates of Finland. These results lead us to determine the rank of the Π matrix as 8 by using the λ_{max} and λ_{trace} tests.

***Table 6.6** - χ^2 statistics calculated for the nine nominal exchange rate indices of Finland for the test of long-run exclusion*

Exch. Rates	χ^2
Fin. Markka/Aus. Schilling	51.17
Fin. Markka/Bel.&Lux. Franc	88.13
Fin. Markka/Fra. Franc	77.03
Fin. Markka/Ger. Mark	38.21
Fin. Markka/Ire. Pound	66.15
Fin. Markka/Ita. Lira	41.58
Fin. Markka/Net. Guilder	72.37
Fin. Markka/Por. Escudo	66.70
Fin. Markka/Spa. Peseta	52.00

For the long-run exclusion, we can conclude at all conventional levels of significance that all the nine series should be included in the analysis of long-run relations. The χ^2 statistics calculated are tabulated in Table 6.6 above. Again the χ^2

statistics have 8 degrees of freedom and the critical values are 20.09 for 1%, 15.51 for 5%, and 13.36 for 10% levels of significance.

2.4 France

Table 6.7 below presents the λ_{max} and λ_{trace} test statistics calculated for nine nominal bilateral exchange rate indices for French franc in an I(*1*) model which includes no deterministic components.

Table 6.7 *- The test statistics calculated for respective values of r under the null hypothesis for the French data*

H_o	λ_{max}	λ_{trace}
r=0	131.82	440.83
r=1	92.16	309.02
r=2	69.63	216.86
r=3	50.01	147.22
r=4	37.54	97.21
r=5	30.85	59.67
r=6	17.71	28.82
r=7	10.97	11.11
r=8	0.14	0.14

According to the reported values in Table 6.7, it is possible to conclude that there exist 8 distinct cointegrating vectors by using the λ_{max} and λ_{trace} tests.

Table 6.8 *- χ^2 statistics calculated for the nine nominal exchange rate indices of France for the test of long-run exclusion*

Exch. Rates	χ^2
Fra. Franc/Aus. Schilling	54.10
Fra. Franc/Bel.&Lux. Franc	89.28
Fra. Franc/Fin. Markka	40.54
Fra. Franc/Ger. Mark	40.47
Fra. Franc/Ire. Pound	58.31
Fra. Franc/Ita. Lira	40.78
Fra. Franc/Net. Guilder	79.36
Fra. Franc/Por. Escudo	58.31
Fra. Franc/Spa. Peseta	45.00

The results for the test of long-run exclusion indicate that it is not possible to exclude any of the variables from the long-run analysis. The critical χ^2 values with 8 degrees of freedom are 20.09 for 1%, 15.51 for 5%, and 13.36 for 10% levels of significance. The calculated χ^2 values are given in Table 6.8 above.

2.5 Germany

The results of the prior tests indicate that an I(*1*) model with a constant and trend in the cointegrating relations should be used for the German data.

Table 6.9 *- The test statistics calculated for respective values of r under the null hypothesis for the German data*

H_o	λ_{max}	λ_{trace}
r=0	160.93	535.59
r=1	117.76	374.67
r=2	82.49	256.90
r=3	50.68	174.41
r=4	47.65	123.727
r=5	33.00	76.07
r=6	22.28	43.07
r=7	15.76	20.79
r=8	5.02	5.02

As in the previous sections, λ_{max} and λ_{trace} tests are used to determine the number of cointegrating vectors. At 90% level of significance, λ_{trace} test indicates that the cointegrating rank is 7 when the null hypothesis of r=7 is tested against the alternative $r \neq 7$. However, λ_{max} test results in rejecting the null of r=7 against the alternative r=8. Enders points to this problem and notes that "λ_{max} test has a sharper alternative and it is usually preferred to pin down the number of cointegrating vectors" (p.393). Adopting the suggestions of Hansen and Juselius (1995), the cointegrating rank is 7 in this case.

Table 6.10 below gives the χ^2 statistics calculated to test the long-run exclusion both for 7 and 8 cointegrating vectors. The critical χ^2 values for 7 degrees of freedom are 18.47, 14.07, and 12.02 and for 8 degrees of freedom are 20.09, 15.51, and 13.36 for 1%, 5%, and 10% levels of significance respectively. Therefore, it is not possible to exclude any of the exchange rate indices from the long-run analysis.

***Table 6.10** - χ^2 statistics calculated for the nine nominal exchange rate indices of Germany for the test of long-run exclusion*

Exch. Rates	χ^2_7	χ^2_8
Ger. Mark/Aus. Schilling	58.06	67.58
Ger. Mark/Bel.&Lux. Franc	86.68	99.99
Ger. Mark/Fin. Markka	26.94	40.73
Ger. Mark/Fra. Franc	76.80	90.24
Ger. Mark/Ire. Pound	55.24	66.14
Ger. Mark/Ita. Lira	33.85	46.56
Ger. Mark/Net. Guilder	75.88	86.74
Ger. Mark/Por. Escudo	45.63	59.29
Ger. Mark/Spa. Peseta	55.00	59.00

2.6 Ireland

The model adopted for the Irish data according to the test results is an I(*1*) model with a constant term restricted in the cointegrating relations. The results of this model are summarised in Table 6.11.

As in the previous section, λ_{max} and λ_{trace} tests give different results about the rank of Π. Similarly, at 90% level of significance, λ_{trace} test results in failing to reject the null hypothesis of r=7 against the alternative r≠7. However, λ_{max} test rejects the null of r=7 against the alternative r=8. Again adopting the suggestions of Hansen and Juselius (1995), the cointegrating rank is chosen as 7.

The results for the test of long-run exclusion are rather interesting in this case. At any conventional level of significance, it is not possible to include the nominal bilateral exchange rate between Irish pound and Italian lira in the long-run analysis. The results of this test are tabulated below (see Table 6.12).

***Table 6.11** - The test statistics calculated for respective values of r under the null hypothesis for the Irish data: 1st Model*

H_o	λ_{max}	λ_{trace}
r=0	126.97	474.89
r=1	119.73	347.93
r=2	75.20	228.19
r=3	50.66	152.99
r=4	38.96	102.33
r=5	30.44	63.37
r=6	19.84	32.93
r=7	11.73	13.10
r=8	1.37	1.37

***Table 6.12** - χ^2 statistics calculated for the nine nominal exchange rate indices of Ireland for the test of long-run exclusion: 1st Model*

Exch. Rates	χ^2
Ire. Pound/Aus. Schilling	48.05
Ire. Pound/Bel.&Lux. Franc	76.07
Ire. Pound/Fin. Markka	36.55
Ire. Pound/Fra. Franc	66.93
Ire. Pound/Ger. Mark	42.35
Ire. Pound/Ita. Lira	0.16
Ire. Pound/Net. Guilder	75.91
Ire. Pound/Por. Escudo	75.88
Ire. Pound/Spa. Peseta	47.00

Therefore, the model is re-estimated excluding the nominal bilateral exchange rate between Irish pound and Italian lira. Again, the tests prior to analysis indicated that the model to be used is an I(*1*) model with a constant term restricted in the cointegrating relations.

***Table 6.13** - The test statistics calculated for respective values of r under the null hypothesis for the Irish data: 2nd Model*

H_o	λ_{max}	λ_{trace}
r=0	128.38	430.41
r=1	106.30	302.04
r=2	72.75	195.74
r=3	48.60	122.98
r=4	28.78	74.38
r=5	27.89	45.60
r=6	16.28	17.71
r=7	1.44	1.44

The λ_{max} and λ_{trace} tests lead us to choose the cointegrating rank as 7. In addition, the tests for long-run exclusion indicate that all the remaining variables are relevant in long-run relations.

***Table 6.14** - χ^2 statistics calculated for the nine nominal exchange rate indices of Ireland for the test of long-run exclusion: 2nd Model*

Exch. Rates	χ^2
Ire. Pound/Aus. Schilling	42.28
Ire. Pound/Bel.&Lux. Franc	83.38
Ire. Pound/Fin. Markka	43.45
Ire. Pound/Fra. Franc	72.91
Ire. Pound/Ger. Mark	34.67
Ire. Pound/Net. Guilder	70.62
Ire. Pound/Por. Escudo	70.51
Ire. Pound/Spa. Peseta	50.87

2.7 Italy

According to the results of tests done prior to the analysis, an I(*1*) model with no deterministic components is fit to the Italian data. The results of λ_{max} and λ_{trace} tests indicate that there are 8 distinct cointegrating relations. Table 6.15 provides the calculated values of λ_{max} and λ_{trace}. There is no evidence that any of the exchange rate indices are irrelevant for the long-run analysis (see Table 6.16).

***Table 6.15** - The test statistics calculated for respective values of r under the null hypothesis for the Italian data*

H_0	λ_{max}	λ_{trace}
r=0	126.58	465.92
r=1	110.72	339.34
r=2	76.38	228.63
r=3	51.73	152.24
r=4	38.80	100.52
r=5	31.04	61.72
r=6	19.59	30.68
r=7	9.61	11.09
r=8	1.48	1.48

The critical χ^2 values for 8 degrees of freedom are 20.09, 15.51, and 13.36 for 1%, 5%, and 10% levels of significance respectively.

Table 6.16 *- χ^2 statistics calculated for the nine nominal exchange rate indices of Italy for the test of long-run exclusion*

Exch. Rates	χ^2
Ita. Lira/Aus. Schilling	54.03
Ita. Lira/Bel.&Lux. Franc	75.23
Ita. Lira/Fin Markka	37.85
Ita. Lira/Fra. Franc	75.51
Ita. Lira/Ger. Mark	38.42
Ita. Lira/Ire. Pound	68.10
Ita. Lira/Net. Guilder	72.57
Ita. Lira/Por. Escudo	60.11
Ita. Lira/Spa. Peseta	51.00

2.8 The Netherlands

Table 6.17 below presents the λ_{max} and λ_{trace} test statistics calculated for nine nominal bilateral exchange rate indices for Dutch guilder in an I(*1*) model which includes a constant and a trend in the cointegrating relations.

Table 6.17 *- The test statistics calculated for respective values of r under the null hypothesis for the Dutch data*

H_0	λ_{max}	λ_{trace}
r=0	164.33	589.65
r=1	142.82	425.32
r=2	78.84	282.50
r=3	58.93	203.66
r=4	47.30	144.73
r=5	42.87	97.43
r=6	27.79	54.56
r=7	17.12	26.77
r=8	9.65	9.65

Table 6.18 *- χ^2 statistics calculated for the nine nominal exchange rate indices of the Netherlands for the test of long-run exclusion*

Exch. Rates	χ^2
Net. Guilder/Aus. Schilling	67.11
Net. Guilder/Bel.&Lux. Franc	99.35
Net. Guilder/Fin. Markka	39.29
Net. Guilder/Fra. Franc	89.30
Net. Guilder/Ger. Mark	53.37
Net. Guilder/Ire. Pound	66.84
Net. Guilder/Ita. Lira	48.71
Net. Guilder/Por. Escudo	57.28
Net. Guilder/Spa. Peseta	58.00

Both λ_{max} and λ_{trace} tests indicate that the rank of Π matrix is equal to 8, that is, there are 8 linearly independent cointegrating relations. The tests for long-run exclusion show that all the variables should be included in the long-run analysis. See Table 6.18 for the calculated χ^2 values with 8 degrees of freedom.

2.9 Portugal

An I(*1*) model without any deterministic components is used in this section to analyse the Portuguese data.

***Table 6.19** - The test statistics calculated for respective values of r under the null hypothesis for the Portuguese data*

H_o	λ_{max}	λ_{trace}
r=0	111.77	425.43
r=1	98.64	313.67
r=2	59.05	215.03
r=3	48.05	155.98
r=4	39.28	107.93
r=5	33.13	68.65
r=6	20.76	35.52
r=7	13.53	14.76
r=8	1.23	1.23

***Table 6.20** - χ^2 statistics calculated for the nine nominal exchange rate indices of Portugal for the test of long-run exclusion*

Exch. Rates	χ^2
Por. Escudo/Aus. Schilling	50.07
Por. Escudo/Bel.&Lux. Franc	88.65
Por. Escudo/Fin. Markka	44.76
Por. Escudo/Fra. Franc	88.42
Por. Escudo/Ger. Mark	35.93
Por. Escudo/Ire. Pound	78.46
Por. Escudo/Ita. Lira	41.84
Por. Escudo/Net. Guilder	61.74
Por. Escudo/Spa. Peseta	54.00

The results of λ_{max} and λ_{trace} statistics are summarised in the table above. They both indicate that there exist 8 distinct cointegrating vectors in the Portuguese data. In addition to these findings, it is not possible to exclude any of the variables from the long-run analysis at any conventional significance level. The χ^2 statistics with 8 degrees of freedom calculated for this test are summarised in the table above.

2.10 Spain

The tests prior to the analysis indicate that the Spanish data is not cointegrated because all variables are stationary. The results for this test are summarised in Table 6.21 where Model 1 is an I(*1*) model without any deterministic components, Model 2 is an I(*1*) model with constants in the cointegrating relations, Model 3 is an I(*1*) model with unrestricted constant, and Model 4 is an I(*1*) model which includes a constant and a trend in the cointegrating relations:

***Table 6.21** - The λ_{trace} test statistics calculated for respective values of r for determining the model and the cointegrating rank the Spanish data*

H_0	Model 1	Model2	Model 3	Model4
r=0	457.50	514.84	499.85	539.89
r=1	331.38	379.75	365.31	404.80
r=2	236.06	264.81	251.89	276.47
r=3	165.04	192.50	184.11	207.64
r=4	114.82	142.27	134.11	150.77
r=5	77.20	101.37	93.22	103.76
r=6	42.19	64.63	56.52	66.41
r=7	18.64	29.68	22.85	31.70
r=8	3.06	11.62	4.89	13.47

Comparing these values with the critical values (Hansen and Juselius, 1995), it is not possible to find any cointegrating relations present in the data. In fact these results indicate that the rank of Π is 9, that is, Π has full rank. The interpretation of these is that all the variables are stationary and that they form a system of convergent difference equations.

3. Conclusion

Except for the Irish data, the results were in accordance with the expectations. Since these countries are members of the ERM, their currencies are not allowed to fluctuate freely against each other. Instead, they are limited to wander around a central rate. In addition, Maastricht Treaty requires exchange rate convergence. Therefore, the currencies of the member states are expected to be cointegrated in order for them to have a permanent long-run relationship.

The empirical findings of this chapter indicate that these expectations are true for Austria, Belgium-Luxembourg, Finland, France, Germany, Italy, the Netherlands, Portugal, and Spain. For Ireland, the nominal bilateral exchange rate between Irish pound and Italian lira turned out to be irrelevant for the long-run relationship, and thus excluded from the analysis. The tests for the Spanish data indicated that there exists no cointegration among the nominal bilateral exchange rates because the variables are stationary, and therefore, they form a convergent system of stationary variables.

Therefore, it is possible to conclude that the nominal bilateral exchange rates among the eleven states of the euro zone are convergent in the long-run.

CHAPTER VII: REAL EXCHANGE RATES OF THE EMU STATES

The previous chapters adopted cointegration analyses for the price indices and the nominal bilateral exchange rates of the euro area. This chapter will adopt a similar analysis for the real bilateral exchange rates of Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Portugal, and Spain.

As discussed before, the real exchange rate is a key indicator of a country's competitiveness. The purpose of this chapter is to investigate the competitiveness of each EMU State against the others and find the misalignments, if any.

The real exchange rate indices used in this section are calculated according to equation 3.1. The nominal bilateral exchange rates used in this formula come from the same data set as in the previous chapter.

The real exchange rate series seem to have no deterministic trends and therefore, the models are adopted accordingly (see Appendix B for figures and method of calculations).

1. The Statistical Model and the Tests for Determining the Cointegrating Rank:

The statistical model used in this chapter is identical to the model adopted for the analyses of nominal bilateral exchange rates in the previous chapter; described by equations 5.1, 5.2, 5.3, 5.4 and 5.5. The λ_{max} and λ_{trace} tests explained in section 5.2 will also be adopted in this chapter.

2. Estimation Results:

The bilateral real exchange rates are analysed for each of the eleven EMU countries. The results are summarised in the following sections. The data vector consists of the bilateral real exchange rates calculated using equation 3.1 of Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Spain against each other.

2.1 Austria

Depending on the results of prior tests, a model without any deterministic terms is adopted for the Austrian real exchange rate data.

According to the estimated output, the calculated λ_{max} and λ_{trace} statistics which are summarised in table 7.1 indicate that the cointegrating rank *r* is 9.

Table 7.1 *- The test statistics calculated for respective values of r under the null hypothesis for the Austrian data*

H_o	λ_{max}	λ_{trace}
r=0	127.17	557.25
r=1	116.65	430.08
r=2	73.17	313.43
r=3	64.76	240.25
r=4	53.78	175.50
r=5	37.49	121.72
r=6	35.26	84.23
r=7	32.66	48.97
r=8	15.49	16.31
r=9	0.82	0.82

The results for the test of long-run exclusion indicate that it is not possible to exclude any of the variables from the long-run analysis. See the calculated χ^2 values (Table 7.2 below) when compared with the critical values with 9 degrees of freedom which are 21.66 for 1%, 16.92 for 5%, and 14.69 for 10% levels of significance.

Therefore, it is possible to conclude that nine nominal bilateral exchange rates for Austria has a linear equilibrium relationship in the long-run and it is not possible to exclude any of them from the analysis.

Table 7.2 *- χ^2 statistics calculated for the nine real exchange rate indices of Austria for the test of long-run exclusion*

Exch. Rates	χ^2
Aus. Schilling/Bel. Franc	27.60
Aus. Schilling/Fin. Markka	54.41
Aus. Schilling/Fra. Franc	65.59
Aus. Schilling/Ger. Mark	83.97
Aus. Schilling/Ire. Pound	52.08
Aus. Schilling/Ita. Lira	43.69
Aus. Schilling/Lux. Franc	33.46
Aus. Schilling/Net. Guilder	75.99
Aus. Schilling/Por. Escudo	35.00
Aus. Schilling/Spa. Peseta	66.00

2.2 Belgium

λ_{max} and λ_{trace} tests indicate that the cointegrating rank is 9 for Belgian data. Besides, it is not possible to exclude any of the exchange rate indices from the long-run relationship. Table 7.3 summarises the λ_{max} and λ_{trace} test statistics calculated for the data, and 7.4 provides the calculated values of the χ^2 statistics for the test of long-run exclusion. According to the tests done prior to the analysis, an I(*1*) model without any deterministic components is adopted for Belgium.

Table 7.3 *- The test statistics calculated for respective values of r under the null hypothesis for the Belgium data*

H_0	λ_{max}	λ_{trace}
r=0	132.49	605.48
r=1	118.99	472.99
r=2	94.41	354.00
r=3	69.41	259.59
r=4	59.41	190.19
r=5	52.11	130.78
r=6	34.08	78.67
r=7	26.91	44.58
r=8	15.19	17.68
r=9	2.48	2.48

Table 7.4 *- χ^2 statistics calculated for the nine real exchange rate indices of Belgium for the test of long-run exclusion*

Exch. Rates	χ^2
Bel. Franc/Aus. Schilling	75.46
Bel. Franc/Fin. Markka	55.30
Bel. Franc/Fra. Franc	67.03
Bel. Franc/Ger. Mark	87.75
Bel. Franc/Ire. Pound	51.44
Bel. Franc/Ita. Lira	42.67
Bel. Franc/Lux. Franc	39.00
Bel. Franc/Net. Guilder	73.99
Bel. Franc/Por. Escudo	29.00
Bel. Franc/Spa. Peseta	64.00

2.3 Finland

Prior testing indicates a model similar to the one adopted for both Austrian and Belgian real exchange rates in the previous sections: an I(*1*) model without any deterministic terms. The estimation results are presented in Table 7.5 below for the real bilateral exchange rates of Finland. These results lead us to determine the rank of the Π matrix as 9 by using the λ_{max} and λ_{trace} tests.

Table 7.5 *- The test statistics calculated for respective values of r under the null hypothesis for the Finnish data*

H_o	λ_{max}	λ_{trace}
r=0	137.67	574.10
r=1	122.12	436.43
r=2	80.73	314.31
r=3	72.75	233.58
r=4	53.82	160.82
r=5	42.19	107.00
r=6	24.42	64.81
r=7	24.04	40.38
r=8	16.17	16.34
r=9	0.17	0.17

The results of the long-run exclusion test lead us to conclude at all conventional levels of significance that all the nine series should be included in the analysis of long-run relations as can be observed from the χ^2 statistics with 9 degrees of freedom calculated from the data (see Table 7.6).

Table 7.6 *- χ^2 statistics calculated for the nine nominal exchange rate indices of Finland for the test of long-run exclusion*

Exch. Rates	χ^2
Fin. Markka/Aus. Schilling	48.06
Fin. Markka/Bel. Franc	22.69
Fin. Markka/Fra. Franc	49.83
Fin. Markka/Ger. Mark	79.50
Fin. Markka/Ire. Pound	45.17
Fin. Markka/Ita. Lira	38.68
Fin. Markka/Lux. Franc	29.67
Fin. Markka/Net. Guilder	71.20
Fin. Markka/Por. Escudo	29.00
Fin. Markka/Spa. Peseta	45.00

2.4 France

For the bilateral real exchange rates of France, again an I(*1*) model that includes no deterministic components was adopted. λ_{max} and λ_{trace} test statistics calculated are presented in Table 7.7 below.

Table 7.7 *- The test statistics calculated for respective values of r under the null hypothesis for the French data*

H_o	λ_{max}	λ_{trace}
r=0	133.90	568.15
r=1	126.07	434.24
r=2	85.05	308.17
r=3	63.51	223.12
r=4	49.07	159.61
r=5	36.44	110.54
r=6	35.01	74.11
r=7	21.75	39.10
r=8	17.26	17.35
r=9	0.08	0.08

The λ_{max} and λ_{trace} test statistics reported above indicate that there exists 9 linearly independent cointegrating relations in the data. Furthermore, the results for the test of long-run exclusion indicate that it is not possible to exclude any of the variables from the long-run analysis when the calculated χ^2 values that are given in Table 7.8 below are compared with the critical χ^2 values with 9 degrees of freedom.

Table 7.8 *- χ^2 statistics calculated for the nine real exchange rate indices of France for the test of long-run exclusion*

Exch. Rates	χ^2
Fra. Franc/Aus. Schilling	72.07
Fra. Franc/Bel. Franc	26.08
Fra. Franc/Fin. Markka	58.57
Fra. Franc/Ger. Mark	86.84
Fra. Franc/Ire. Pound	53.64
Fra. Franc/Ita. Lira	41.53
Fra. Franc/Lux. Franc	36.74
Fra. Franc/Net. Guilder	75.68
Fra. Franc/Por. Escudo	31.00
Fra. Franc/Spa. Peseta	61.00

2.5 Germany

The results of the cointegration analysis of the real bilateral exchange rates of Germany using an I(*1*) model without any deterministic components are tabulated below:

Table 7.9 *- The test statistics calculated for respective values of r under the null hypothesis for the German data*

H_o	λ_{max}	λ_{trace}
r=0	129.28	540.39
r=1	100.87	411.11
r=2	75.51	310.23
r=3	61.48	234.73
r=4	49.89	173.24
r=5	40.28	123.35
r=6	35.43	83.06
r=7	31.50	47.63
r=8	15.63	16.13
r=9	0.49	0.49

The λ_{max} and λ_{trace} statistics indicate that the rank of Π is 9, that is, there exist 9 linearly independent long-run equilibrium relations among the real bilateral exchange rates of Germany. In addition, there is no evidence to prove that any of these variables are irrelevant in the long-run analysis. The χ^2 statistics given in Table 7.10 have 9 degrees of freedom.

Table 7.10 *- χ^2 statistics calculated for the nine nominal exchange rate indices of Germany for the test of long-run exclusion*

Exch. Rates	χ^2
Ger. Mark/Aus. Schilling	64.78
Ger. Mark/Bel. Franc	26.25
Ger. Mark/Fin. Markka	55.67
Ger. Mark/Fra. Franc	65.32
Ger. Mark/Ire. Pound	51.70
Ger. Mark/Ita. Lira	40.21
Ger. Mark/Lux. Franc	32.61
Ger. Mark/Net. Guilder	78.21
Ger. Mark/Por. Escudo	34.00
Ger. Mark/Spa. Peseta	66.00

2.6 Ireland

The λ_{max} and λ_{trace} statistics, which are given in Table 7.11, indicate that the cointegrating rank is 9 for the Irish real exchange rates when an I(*1*) model without any deterministic components is used for the analysis.

Table 7.11 *- The test statistics calculated for respective values of r under the null hypothesis for the Irish data: 1st Model*

H_o	λ_{max}	λ_{trace}
r=0	133.03	574.46
r=1	120.30	441.42
r=2	87.03	321.12
r=3	64.67	234.09
r=4	55.25	169.42
r=5	36.84	114.17
r=6	34.58	77.33
r=7	26.33	42.75
r=8	16.41	16.42
r=9	0.01	0.01

The calculated χ^2 values when compared with the critical values with 9 degrees of freedom, which are 21.66, 16.92, and 14.69 for 1%, 5%, and 10% levels of significance respectively, indicate that at the 1% level we end up excluding Belgium from the long-run analysis (see Table 7.12).

Table 7.12 *- χ^2 statistics calculated for the nine real exchange rate indices of Ireland for the test of long-run exclusion: 1st Model*

Exch. Rates	χ^2
Ire. Pound/Aus. Schilling	52.50
Ire. Pound/Bel. Franc	21.30
Ire. Pound/Fin. Markka	45.22
Ire. Pound/Fra. Franc	59.85
Ire. Pound/Ger. Mark	75.94
Ire. Pound/Ita. Lira	39.93
Ire. Pound/Lux. Franc	22.95
Ire. Pound/Net. Guilder	71.92
Ire. Pound/Por. Escudo	35.00
Ire. Pound/Spa. Peseta	57.00

Table 7.13 *- The test statistics calculated for respective values of r under the null hypothesis for the Irish data: 2nd Model*

H_o	λ_{max}	λ_{trace}
r=0	135.51	460.63
r=1	101.21	325.12
r=2	57.57	223.92
r=3	52.67	166.34
r=4	41.69	113.67
r=5	32.12	71.98
r=6	21.37	39.86
r=7	17.73	18.50
r=8	0.76	0.76

Table 7.14 *- χ^2 statistics calculated for the nine real exchange rate indices of Ireland for the test of long-run exclusion:2nd Model*

Exch. Rates	χ^2
Ire. Pound/Aus. Schilling	59.88
Ire. Pound/Fin. Markka	37.26
Ire. Pound/Fra. Franc	64.70
Ire. Pound/Ger. Mark	71.38
Ire. Pound/Ita. Lira	42.67
Ire. Pound/Lux. Franc	54.01
Ire. Pound/Net. Guilder	63.15
Ire. Pound/Por. Escudo	49.22
Ire. Pound/Spa. Peseta	73.00

Therefore, the model is re-estimated excluding Belgium. According to the results of this model, it can be concluded that the cointegrating rank is 8, the variables are cointegrated although the bilateral real exchange rate of Irish pound versus Belgian franc is no more present in this long-run relationship. In addition, the model is re-analysed for long-run exclusion and all variables are found to be relevant for the long-run analysis. The results of this second model are summarised in Tables 7.13 and 7.14 which are given above.

2.7 Italy

The model adopted for the Italian real exchange rate indices is the same as the previous ones, without any deterministic components. The λ_{max} and λ_{trace} statistics both show that the cointegrating rank is 9.

Table 7.15 *- The test statistics calculated for respective values of r under the null hypothesis for the Italian data*

H_o	λ_{max}	λ_{trace}
r=0	144.74	593.11
r=1	125.20	448.38
r=2	78.42	323.17
r=3	69.76	244.75
r=4	57.70	174.99
r=5	39.80	117.29
r=6	34.87	77.49
r=7	25.42	42.62
r=8	16.54	17.20
r=9	0.66	0.66

Table 7.16 *- χ^2 statistics calculated for the nine real exchange rate indices of Italy for the test of long-run exclusion*

Exch. Rates	χ^2
Ita. Lira/Aus. Schilling	63.32
Ita. Lira/Bel. Franc	30.32
Ita. Lira/Fin Markka	46.64
Ita. Lira/Fra. Franc	52.07
Ita. Lira/Ger. Mark	83.52
Ita. Lira/Ire. Pound	43.31
Ita. Lira/Lux. Franc	38.82
Ita. Lira/Net. Guilder	75.90
Ita. Lira/Por. Escudo	30.00
Ita. Lira/Spa. Peseta	62.00

The results of the long-run exclusion test indicate that none of the variables can be excluded from the analysis. See Table 7.16 for the calculated χ^2 values with 9 degrees of freedom.

2.8 Luxembourg

The tests prior to the analysis indicate that the Luxembourg data is stationary. The results are provided in Table 7.17. The models are identical to those in section 3.10 of Chapter VI. Comparing the values in Table 7.17 with the critical values (Hansen and Juselius, 1995), the rank of Π is found to be 10, that is, Π has full rank. Therefore, all the variables are stationary and they form a system of convergent difference equations.

Table 7.17 *- The λ_{trace} test statistics calculated for respective values of r for determining the model and the cointegrating rank the Luxembourg data*

H_0	Model 1	Model 2	Model 3	Model 4
r=0	595.047	649.432	628.874	664.466
r=1	463.799	514.423	495.316	530.904
r=2	352.834	388.083	372.476	406.873
r=3	265.020	292.466	278.626	309.005
r=4	194.195	220.136	208.274	229.312
r=5	132.277	155.431	147.982	167.737
r=6	80.830	103.483	99.233	118.285
r=7	46.644	68.907	64.659	71.811
r=8	18.863	36.333	35.898	40.129
r=9	3.650	15.188	14.779	15.088

2.9 The Netherlands

The results of the prior tests indicated that an I(*1*) model that does not have any deterministic components should be fit to the Dutch data. According to this model, the calculated λ_{max} and λ_{trace} statistics are shown in Table 7.18 below.

At any conventional significance level, it is possible to choose the cointegrating rank as 9 as a result of both tests. In addition, the calculated χ^2 statistics with 9 degrees of freedom (see Table 7.19) indicate that none of the real exchange rate indices can be excluded from the long-run analysis.

Table 7.18 *- The test statistics calculated for respective values of r under the null hypothesis for the Dutch data*

H_o	λ_{max}	λ_{trace}
r=0	137.45	552.82
r=1	100.43	415.37
r=2	87.61	314.94
r=3	61.94	227.33
r=4	49.40	165.39
r=5	35.76	115.99
r=6	35.12	80.23
r=7	28.38	45.10
r=8	16.72	16.73
r=9	0.00	0.00

Table 7.19 *- χ^2 statistics calculated for the nine real exchange rate indices of the Netherlands for the test of long-run exclusion*

Exch. Rates	χ^2
Net. Guilder/Aus. Schilling	64.71
Net. Guilder/Bel. Franc	26.11
Net. Guilder/Fin. Markka	52.84
Net. Guilder/Fra. Franc	65.07
Net. Guilder/Ger. Mark	83.33
Net. Guilder/Ire. Pound	51.34
Net. Guilder/Ita. Lira	41.02
Net. Guilder/Lux. Franc	31.76
Net. Guilder/Por. Escudo	33.00
Net. Guilder/Spa. Peseta	66.00

2.10 Portugal

Similar to the real exchange rate indices of Luxembourg, the tests prior to the analysis indicate that the Portuguese data is also stationary (see Table 7.20).

When these values in Table 7.20 are compared with the critical values given by Hansen and Juselius (1995), the rank of Π is found to be 10, that is, Π has full rank. This shows that all the variables are stationary and that they form a system of convergent difference equations.

Table 7.20 *- The λ_{trace} test statistics calculated for respective values of r for determining the model and the cointegrating rank the Portuguese data*

H_0	*Model 1*	*Model 2*	*Model 3*	*Model 4*
r=0	577.475	615.489	584.674	625.047
r=1	455.833	489.008	458.456	498.188
r=2	342.844	369.725	351.482	391.002
r=3	255.766	282.182	263.938	293.866
r=4	181.421	207.608	195.348	216.213
r=5	126.246	150.514	142.777	162.295
r=6	77.881	101.996	94.539	113.414
r=7	44.188	67.999	60.560	74.213
r=8	19.860	36.111	33.111	43.556
r=9	3.530	15.990	14.690	16.109

2.11 Spain

The Spanish data is found to be stationary in the tests prior to the analysis and hence, not cointegrated. Π is found to be having full rank. Thus, the data forms a system of convergent difference equations, as the Luxembourg and Portuguese data. See Table 7.21 for the results.

Table 7.21 *- The λ_{trace} test statistics calculated for respective values of r for determining the model and the cointegrating rank the Spanish data*

H_0	*Model 1*	*Model 2*	*Model 3*	*Model 4*
r=0	547.763	621.540	597.883	637.110
r=1	418.048	490.913	472.204	510.940
r=2	308.706	370.283	356.030	393.618
r=3	236.542	286.104	271.851	297.012
r=4	174.492	214.015	202.143	221.350
r=5	119.133	152.150	145.022	161.706
r=6	75.948	102.337	95.619	111.188
r=7	41.282	65.171	58.528	67.526
r=8	17.986	37.428	34.953	37.036
r=9	3.660	14.139	13.432	14.775

Comparing the values in Table 7.21 with the critical values given by Hansen and Juselius (1995), the rank of Π is found to be 10 i.e. Π has full rank.

3. Conclusion

The empirical findings of this chapter indicate that the real bilateral exchange rate indices of Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Portugal, and Spain are convergent among each other.

In fact, the data for Luxembourg, Portugal and Spain were found to be stationary, and therefore they form systems of convergent difference equations. For Austria, Belgium, Finland, France, Germany, and Italy, the real bilateral exchange rate indices are cointegrated, and so they are related in the long-run.

For the Irish data, the real exchange rate between Ireland and Belgium is found to be irrelevant in the long-run analysis at 1% significance level, and thus excluded from the long-run analysis. The data was found to be cointegrated after the exclusion of this index. However, if we do not exclude the real exchange rate index of Ireland against Belgium at other conventional levels of significance, the data is again cointegrated.

Therefore, it is possible to conclude that for each EMU country, the real bilateral exchange rates against other ten countries have a long-run equilibrium relationship, that is, they are convergent. This result is rather expected because in the previous chapters, it is found that the nominal bilateral exchange rates and prices are convergent in the long-run. In addition, inflation convergence and nominal exchange rate convergence are required by the Maastricht Treaty. Since real exchange rate is an important measure of competitiveness, the empirical findings of this chapter indicate that the level of competitiveness of each country participating in the EMU against others is also convergent.

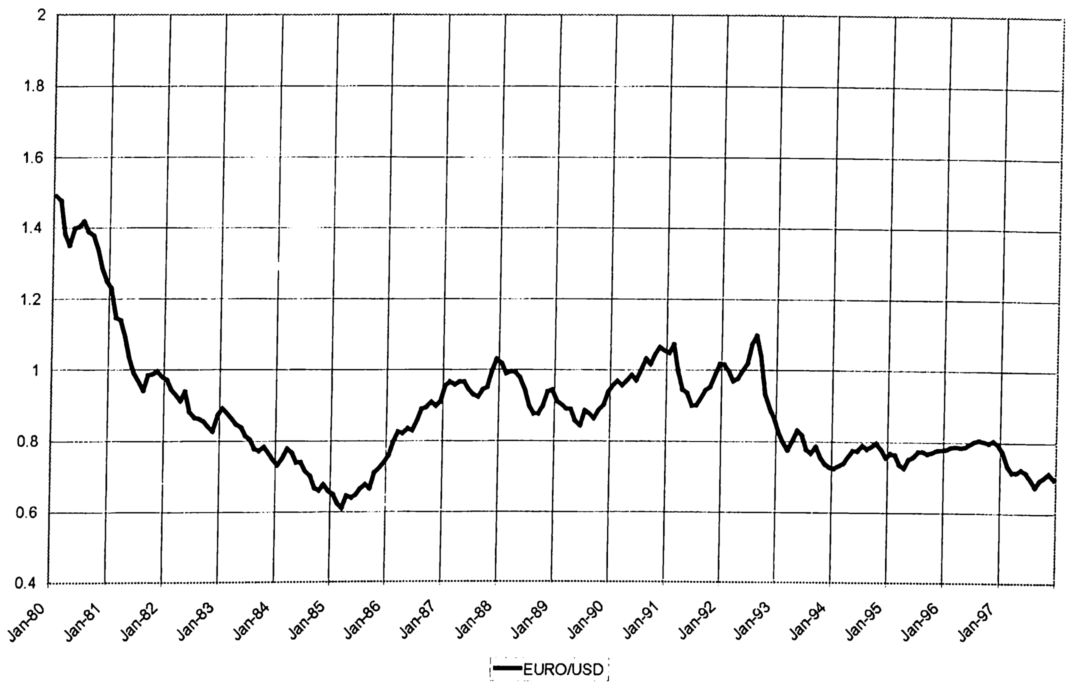
CHAPTER VIII: DOES PPP HOLD?

To determine whether the PPP hypothesis holds for the new currency against the US dollar, Japanese yen and Turkish lira, three real exchange rate indices for euro are calculated using equation (3.1). However, the price index in euros and the nominal exchange rate indices of US dollar, Turkish lira, and Japanese yen against euro are not available. Therefore, the first step is to calculate a price index and nominal exchange rate indices for the new euro zone.

The existing currency unit of the European Union, ECU, includes the currencies of non-participating countries as the British pound, Danish krone, and Greek drachma, whereas Austrian schilling and Finnish markka are not contained in the composition of the ECU. This rules out the possibility of using ECU price index. The weights of the currencies forming ECU are determined by the trade volume of the respective countries. Thus, a similar method is adopted here: the weights of each country's price index in the composite price index are decided according to its trade volume. The same weights are used in calculating nominaş exchange rate indices of euro against the US dollar, Japanese yen, and Turkish lira. The description of the calculations and the respective weights are given in Appendix C.

After calculating the indices, equation (3.1) is adopted for the US dollar, Japanese yen and Turkish lira, so three real exchange rate series are calculated. Figures 8.1, 8.2 and 8.3 show the three real exchange rate indices: euro for US dollar, euro for Japanese yen, and euro for Turkish lira respectively. If the PPP hypothesis holds, the real exchange rate will fluctuate around "1."

Figure 8.1 *- The real exchange rate index of euro for US dollar*



In order to test whether PPP holds, one should determine whether the changes in the real exchange rate are permanent or temporary. Temporary changes in real exchange rate imply that PPP holds in the long-run whereas permanent changes mean that PPP does not hold either in the short-run or in the long-run. If the changes are permanent, the real exchange rate index should exhibit a random walk.

$$(r_t - \bar{r}) = a \cdot (r_{t-1} - \bar{r}) + \varepsilon_t \qquad (8.1)$$

where, r_t: real exchange rate at time t,

$\bar{r}$: long-run equilibrium level of real multilateral exchange rate,

ε_t: random disturbance term at time t (assume: cov $(r_{t-j}, \varepsilon_t)=0$; $\varepsilon_t \sim N(0,\sigma^2)$).

After all those assumptions are made, "*a*" determines the long-run behaviour of the real exchange rate.

If "*a*" takes a value between 0 and 1, the process is stable and assuming there is no random disturbance term, the real exchange rate will converge and eventually be equal to its long-run equilibrium level. Thus, under those conditions, $(r_t - \bar{r})$ is a temporary deviation. If "a" is equal to 1, the process is a random walk and there is no such long-run value to which r_t will converge (Selçuk, 1993).

To determine whether the real exchange rate indices are random walk processes, the equation below is estimated using the least squares method for each of the three series:

$$\Delta \ln r_t = \beta_0 + \gamma \ln r_{t-1} + \sum_{i=1}^{k} \beta_i \Delta \ln r_{t-1} + \varepsilon_t \qquad (8.2)$$

Δ denotes first differences, $\ln r_t$ denotes the value of the natural logarithm of the r series at time t, and ε_t is a white noise random disturbance. Enough lags of the dependent variable should be included to remove autocorrelation.

Below is the estimation output for the period of January 1980-December 1997 of the euro/$ real exchange rate, denoted by U:[5]

$$\Delta \ln U_t = -0.006 - 0.028 \ln U_{t-1} + 0.358 \Delta \ln U_{t-1} \qquad (8.3)$$

If γ is not significantly different from zero, the process is a random walk, meaning PPP does not hold. In order to test the random walk hypothesis, the Dickey-Fuller test is used. The t-statistic calculated for "γ=0" is equal to -2.85. Thus, the null hypothesis of a random walk could not be rejected at 5% and 1% levels of significance while we can reject the presence of a unit root at 10% when t-statistic is compared to the Dickey-Fuller critical values (Enders, 1995).

Similar testing procedures are repeated for euro/yen and euro/TL real exchange rate indices. The results for the euro/yen real exchange rate series for the same period are:[6]

[5] Insignificant variables are excluded.
[6] Insignificant variables are excluded.

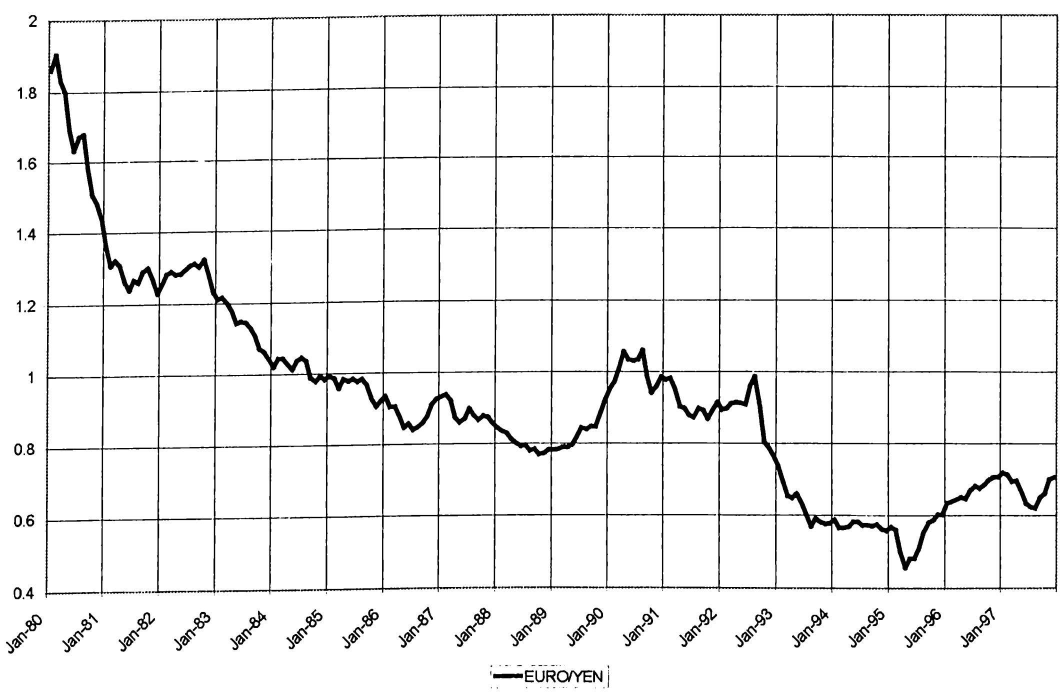
$$\Delta \ln J_t = -0.005 - 0.016 \ln J_{t-1} + 0.411 \Delta \ln J_{t-1} - 0.142 \Delta \ln J_{t-2} \quad (8.4)$$

where J denotes the euro/yen real exchange rate. The null hypothesis of a unit root cannot be rejected at any conventional level of significance when the calculated t-statistic (-2.45) for "γ" is compared with the critical Dickey-Fuller values.

For the period between 1980-1997, the data for the euro/TL real exchange rate index also indicates the failure of rejecting the null hypothesis of a unit root at 1%, 5%, and 10% levels of significance:[7]

$$\Delta \ln T_t = 0.001 - 0.018 \ln T_{t-1} + 0.395 \Delta \ln T_{t-1} - 0.123 \Delta \ln T_{t-3} \quad (8.5)$$

***Fgure 8.2** - The real exchange rate index of euro for Japanese yen*

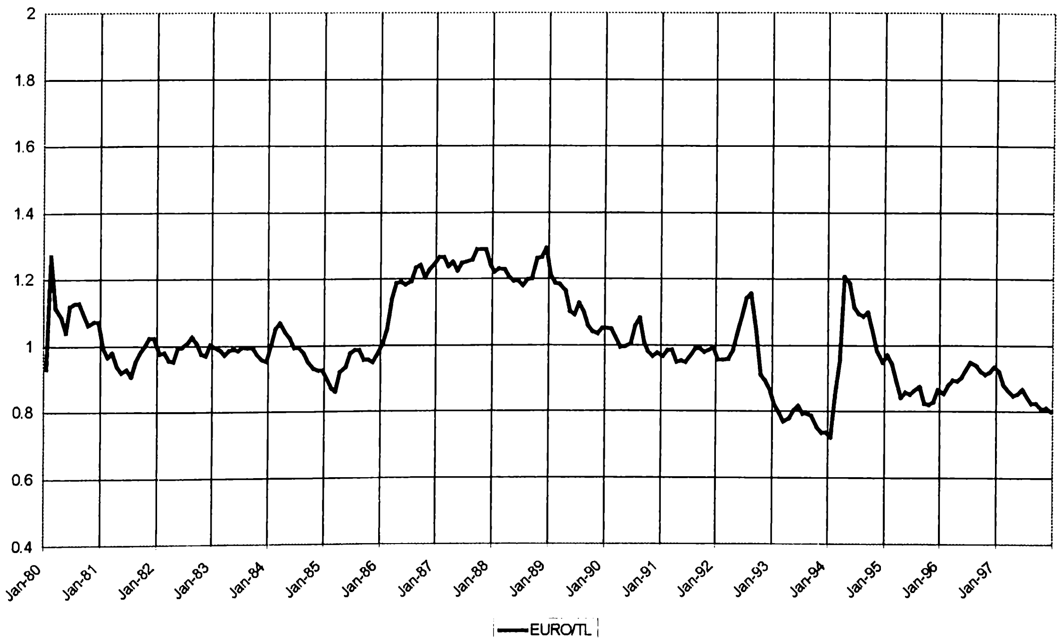


Thus, we can conclude that euro/$, euro/yen and euro/TL real exchange rate indices are non-stationary at 5% and 1% levels of significance. This means that PPP hypothesis does not hold for euro against US dollar, Japanese yen, and Turkish lira given the data set at 95% and 99% levels of confidence.

[7] Insignificant variables are excluded.

In addition, the real exchange rate indices calculated indicate that euro is undervalued against US dollar, Japanese yen, and Turkish lira.

Figure 8.3 *- The real exchange rate index of euro for Turkish lira*



CHAPTER IX: CONCLUSION

This study aimed to investigate the long-run equilibrium relationships among prices and exchange rates of eleven countries that will participate in EMU on 1 January 1999. The Maastricht Treaty, which is the basis of the European Economic and Monetary Union (EMU), put forth some criteria to be met by 1998 for candidates to become a member of EMU. These requirements include inflation and interest rate convergence, exchange rate stability, and fiscal stability. Based on meeting these requirements, the European Commission recommended the European Council the membership of eleven countries by March 1998: Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Spain. On 2-3 May 1998, the European Council decided that these eleven countries will participate in EMU on 1 January 1999 and adopt euro as their single currency.

The empirical findings indicate that there exists a long-run equilibrium relationship among the eleven price indices of the EMU countries. Cointegration analysis was used for this purpose and the cointegrating rank was found to be 10, implying that there exists 10 linearly independent cointegrating relations among the price levels.

As the Maastricht Treaty required exchange rate convergence and membership to the ERM at least two years before the beginning of the third stage, the nominal bilateral exchange rates of the participating countries are expected to move together in the long-run. Again the cointegration analysis is used to analyse the nominal bilateral exchange rates. Austria, Belgium-Luxembourg, Finland, France, Germany, Italy, the Netherlands, Portugal, and Spain are found to be satisfying these expectations, there is a small problem in the Irish data such that the nominal exchange rate of Irish pound/Italian lira is not relevant in the long-run equilibrium relationship.

The bilateral real exchange rates for these countries must converge if their prices and nominal exchange rates are converging. The seventh chapter focused on this issue by adopting cointegration analysis. For all the eleven EMU States, bilateral real exchange rates have an equilibrium relationship in the long-run. Therefore, it is possible to conclude that their real exchange rates are convergent.

It is possible to conclude that these eleven countries that will participate in EMU starting from 1 January 1999 meet the convergence criteria of the Maastricht Treaty for exchange rates and prices.

Finally, to find the alignment of the new currency, euro, against US dollar, Japanese yen and Turkish lira, the PPP hypothesis is tested for the three real exchange rate indices: euro versus US dollar, euro versus Japanese yen, euro versus Turkish lira. These tests indicated that the real exchange rates for euro against the US dollar, Japanese yen and Turkish lira are unit root processes. Therefore, it is possible to conclude that there is no evidence of PPP hypothesis in the long-run.

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APPENDICES

A. THE DATA SET

1. Prices

The price indices of eleven EMU States, Turkey, Japan , and the United States are taken from International Financial Statistics (IFS) by IMF. The details of these data are given below:

***Table A.1.1** - The description of the price indices used in this study*

Country	*Period*	*Descriptor*	*Time Series Key*
Austria	1980:1-1997:12	Consumer Prices	12264 ZF
Belgium	1980:1-1997:12	Consumer Prices	12464 ZF
Finland	1980:1-1997:12	Consumer Prices	17264 ZF
France	1980:1-1997:12	Consumer Prices	13264 ZF
Germany	1980:1-1997:12	Consumer Prices	13464 ZF
Ireland	1980:1-1997:12	Producer Prices	17863A ZF
Italy	1980:1-1997:12	Consumer Prices	13664 ZF
Luxembourg	1980:1-1997:12	Consumer Prices	13764 ZF
Netherlands	1980:1-1997:12	Consumer Prices	13864 ZF
Portugal	1980:1-1997:12	Consumer Prices	18264 ZF
Spain	1980:1-1997:12	Consumer Prices	18464 ZF
United States	1980:1-1997:12	Consumer Prices	11164 ZF
Turkey	1980:1-1997:12	Consumer Prices	18664 ZF
Japan	1980:1-1997:12	Consumer Prices	15864 ZF

2. Nominal Exchange Rates

The nominal exchange rates of eleven EMU States – Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Portugal, and Spain – against US dollar are taken from International Financial Statistics (IFS). In addition, the nominal exchange rates of yen/$ and TL/$ used to calculate the real exchange rate indices of euro for Japanese yen and euro for Turkish lira are also taken from IFS. The details are given below in Table A.2.1.

Table A.2.1 - The description of the nominal exchange rate indices used in this study

Country	*Period*	*Descriptor*	*Time Series Key*
Austria	1980:1-1997:12	Official Rate (N.C./$)	122 AF ZF
Belgium	1980:1-1997:12	Market Rate (N.C./$)	124 AF ZF
Finland	1980:1-1997:12	Official Rate (N.C./$)	172 AF ZF
France	1980:1-1997:12	Official Rate (N.C./$)	132 AF ZF
Germany	1980:1-1997:12	Market Rate (N.C./$)	134 AF ZF
Ireland	1980:1-1997:12	Market Rate (N.C./$)	178 AF ZF
Italy	1980:1-1997:12	Market Rate (N.C./$)	136 AF ZF
Luxembourg	1980:1-1997:12	Market Rate (N.C./$)	137 AF ZF
Netherlands	1980:1-1997:12	Market Rate (N.C./$)	138 AF ZF
Portugal	1980:1-1997:12	Market Rate (N.C./$)	182 AF ZF
Spain	1980:1-1997:12	Market Rate (N.C./$)	184 AF ZF
Turkey	1980:1-1997:12	Market Rate (N.C./$)	186 AF ZF
Japan	1980:1-1997:12	Market Rate (N.C./$)	158 AF ZF

B. REAL BILATERAL EXCHANGE RATES

The real bilateral exchange rates for the eleven EMU countries are calculated using equation (3.1). Base year for the price indices and nominal bilateral exchange rates used in these calculations is 1990. The variables are normalised to 1 for 1990. The real exchange rates are expected to fluctuate around "1" if the PPP hypothesis holds. The graphs of the real bilateral exchange rates are given in the following pages.

***Figure B.1** - The bilateral real exchange rates for Austria*

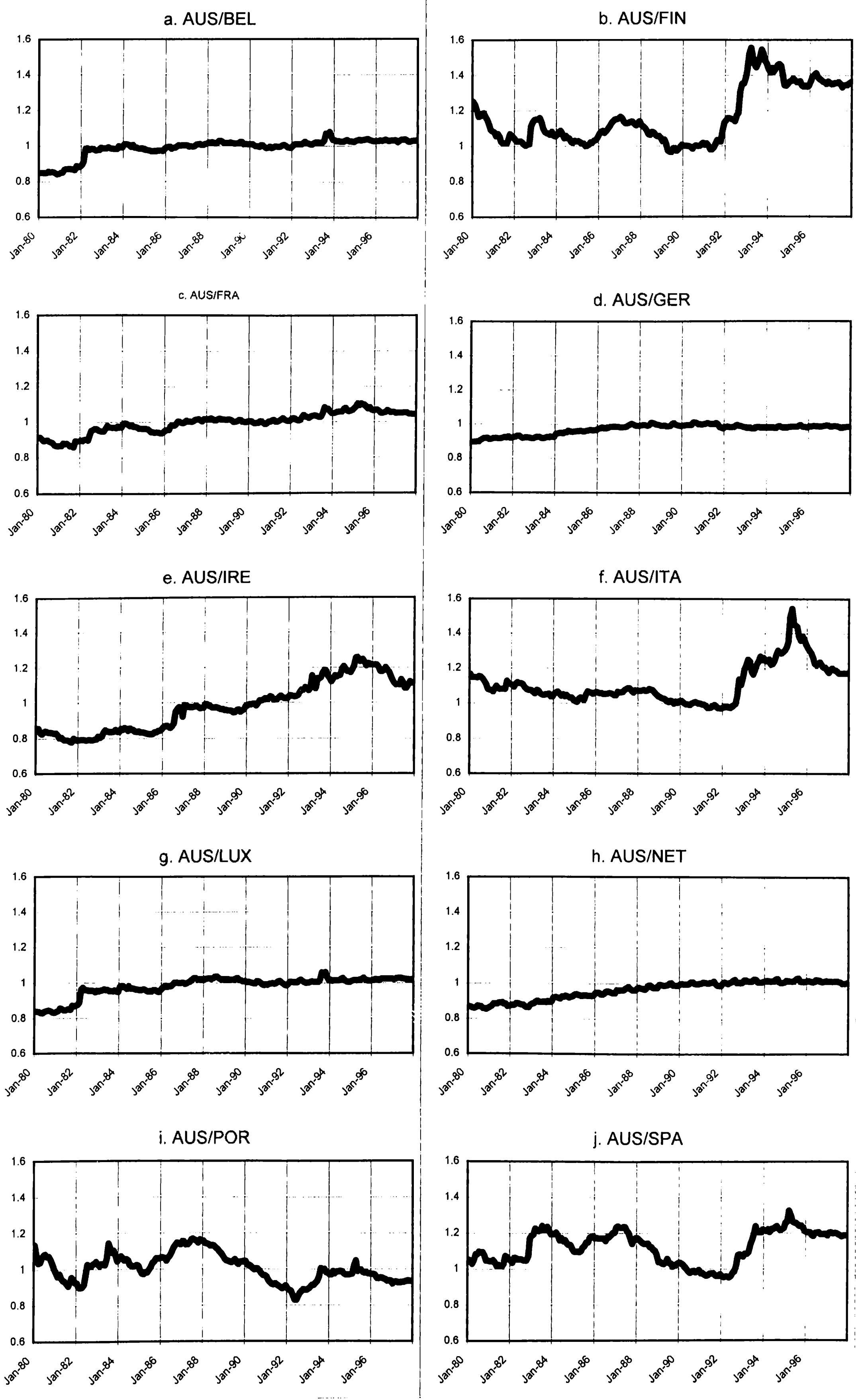


Figure B.2 *- The bilateral real exchange rates of Belgium*

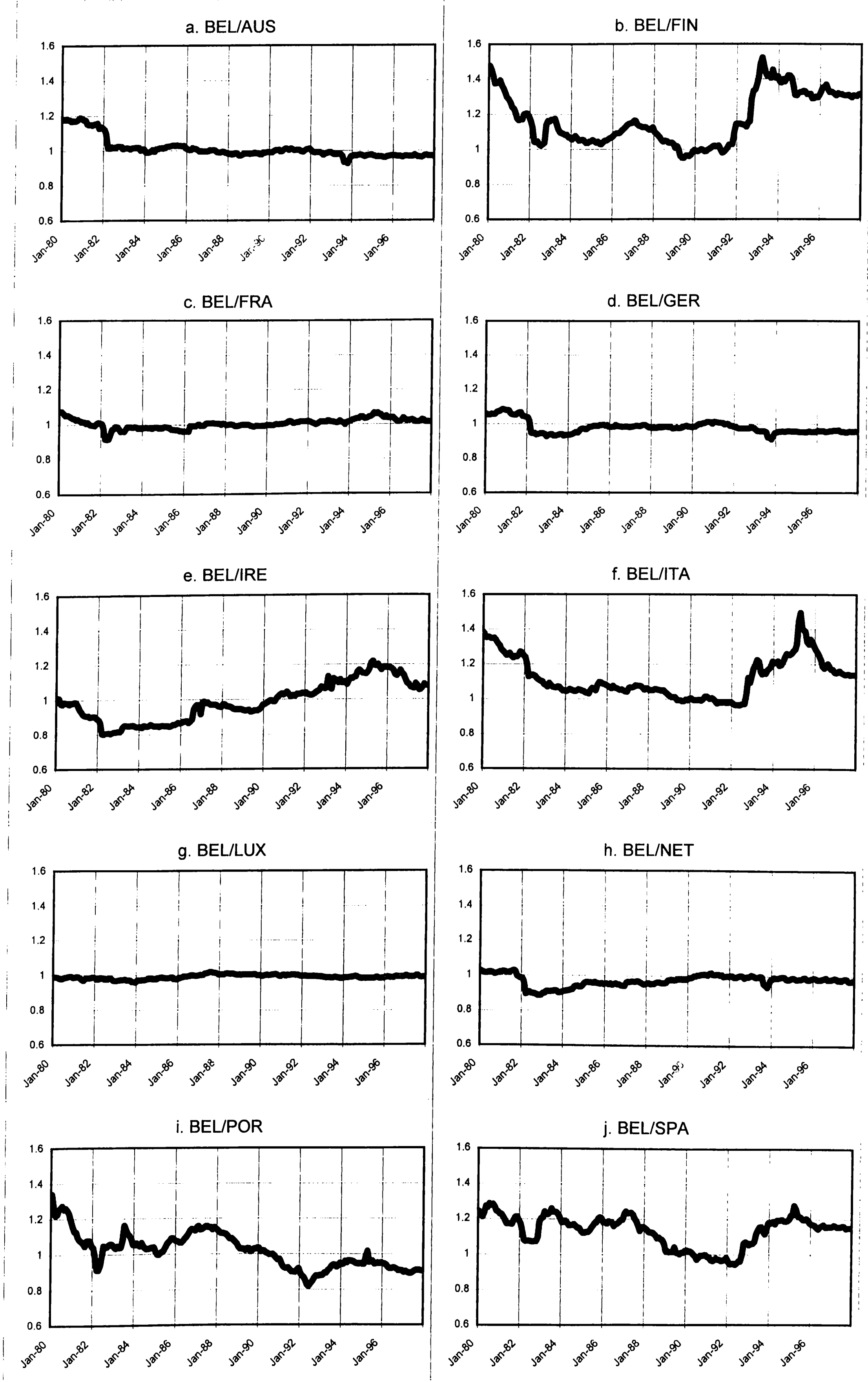


Figure B.3 - *The bilateral real exchange rates for Finland*

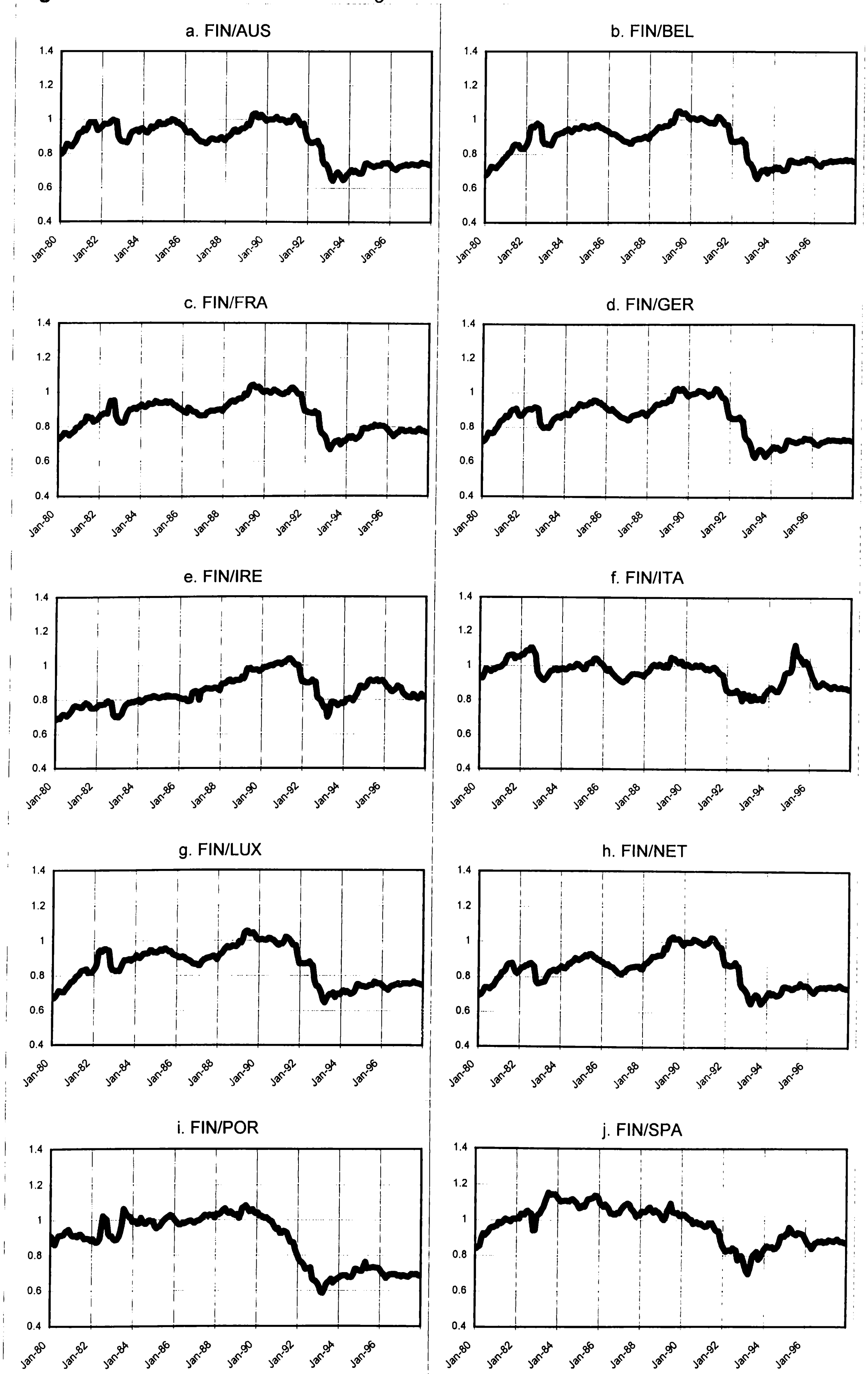


Figure B.4 *- The bilateral real exchange rates for France*

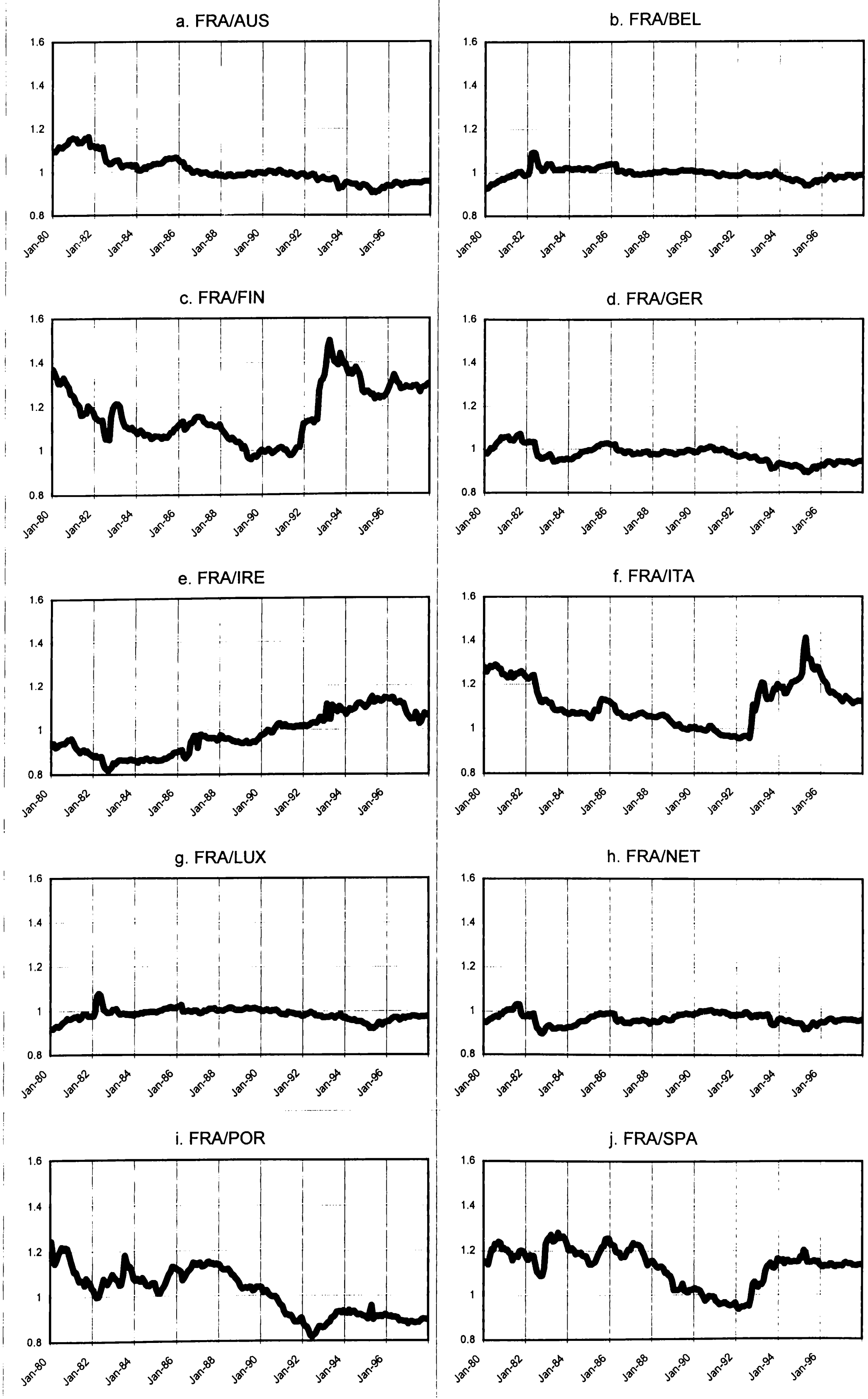


Figure B.5 *- The bilateral real exchange rates for Germany*

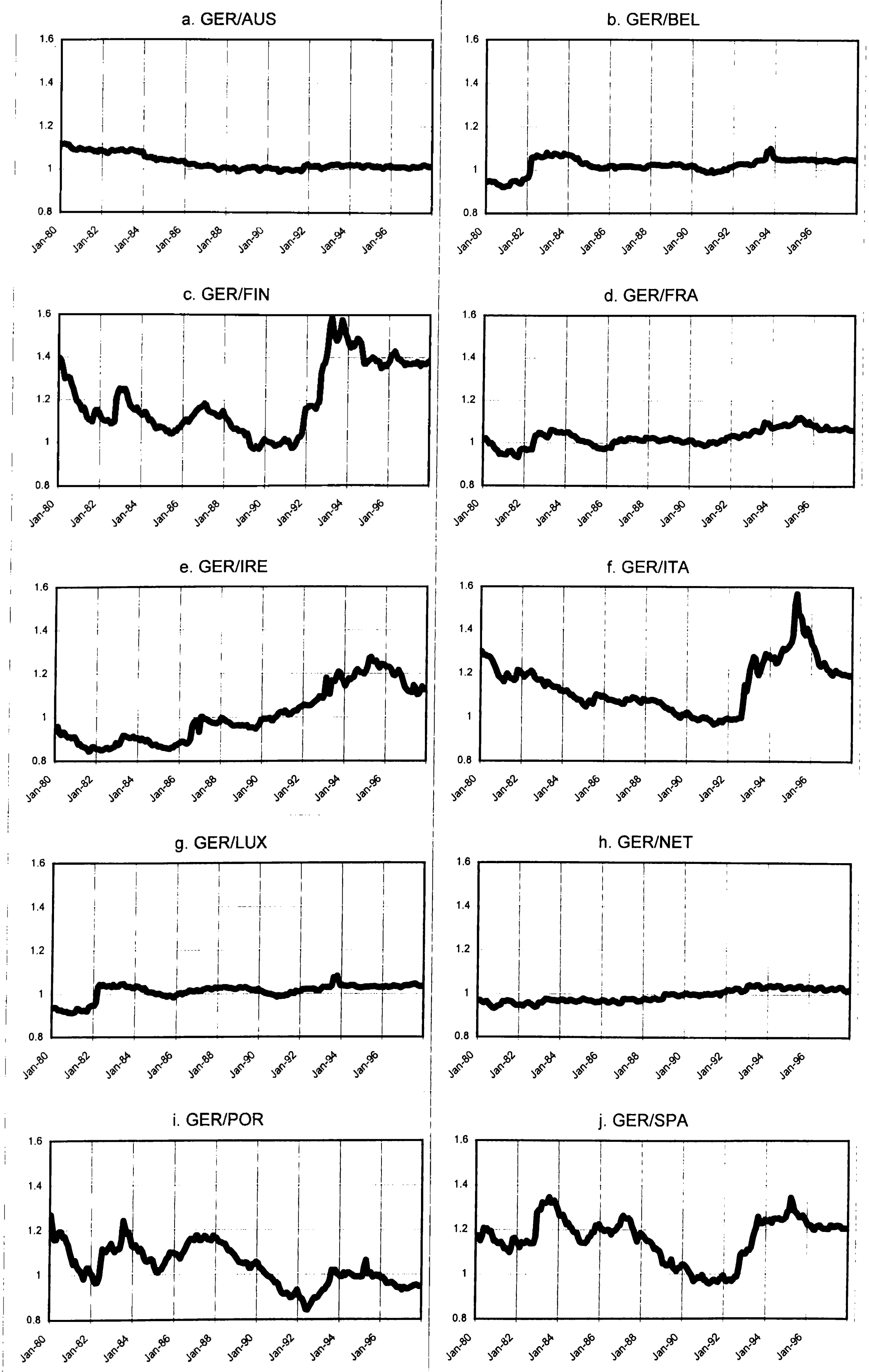


Figure B.6 - *The bilateral real exchange rates for Ireland*

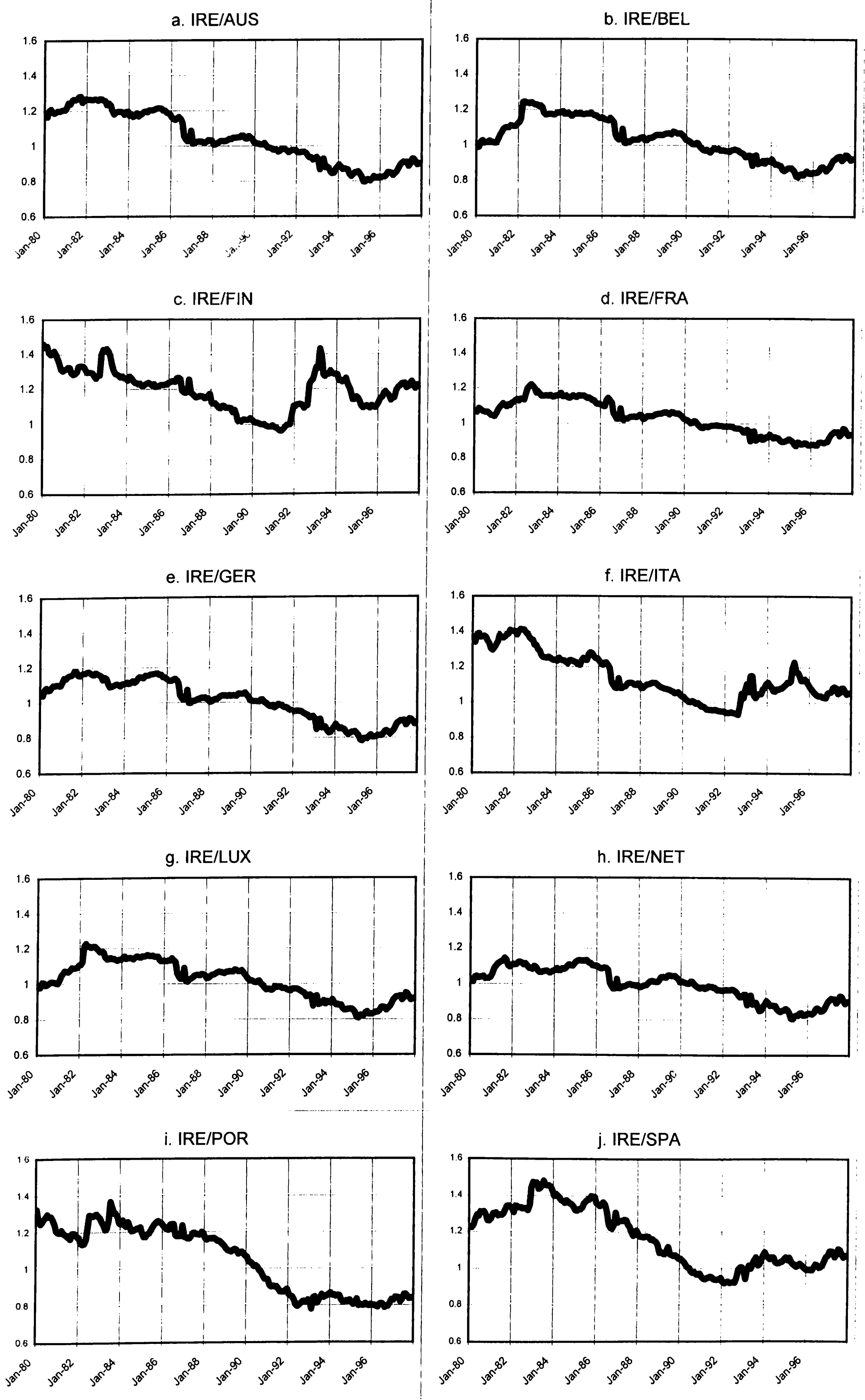


Figure B.7 *- The bilateral real exchange rates for Italy*

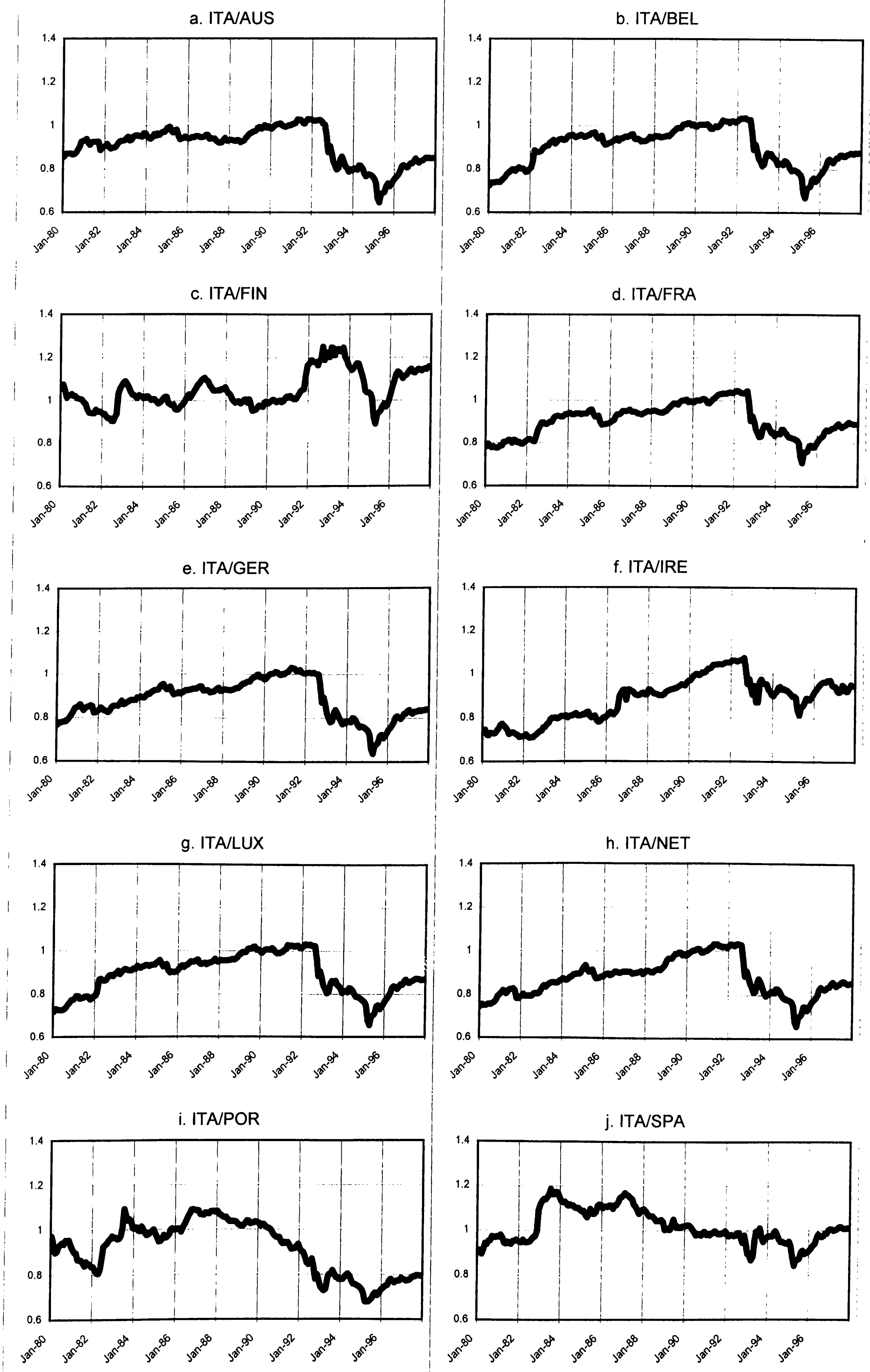


Figure B.8 - *The bilateral real exchange rates for Luxembourg*

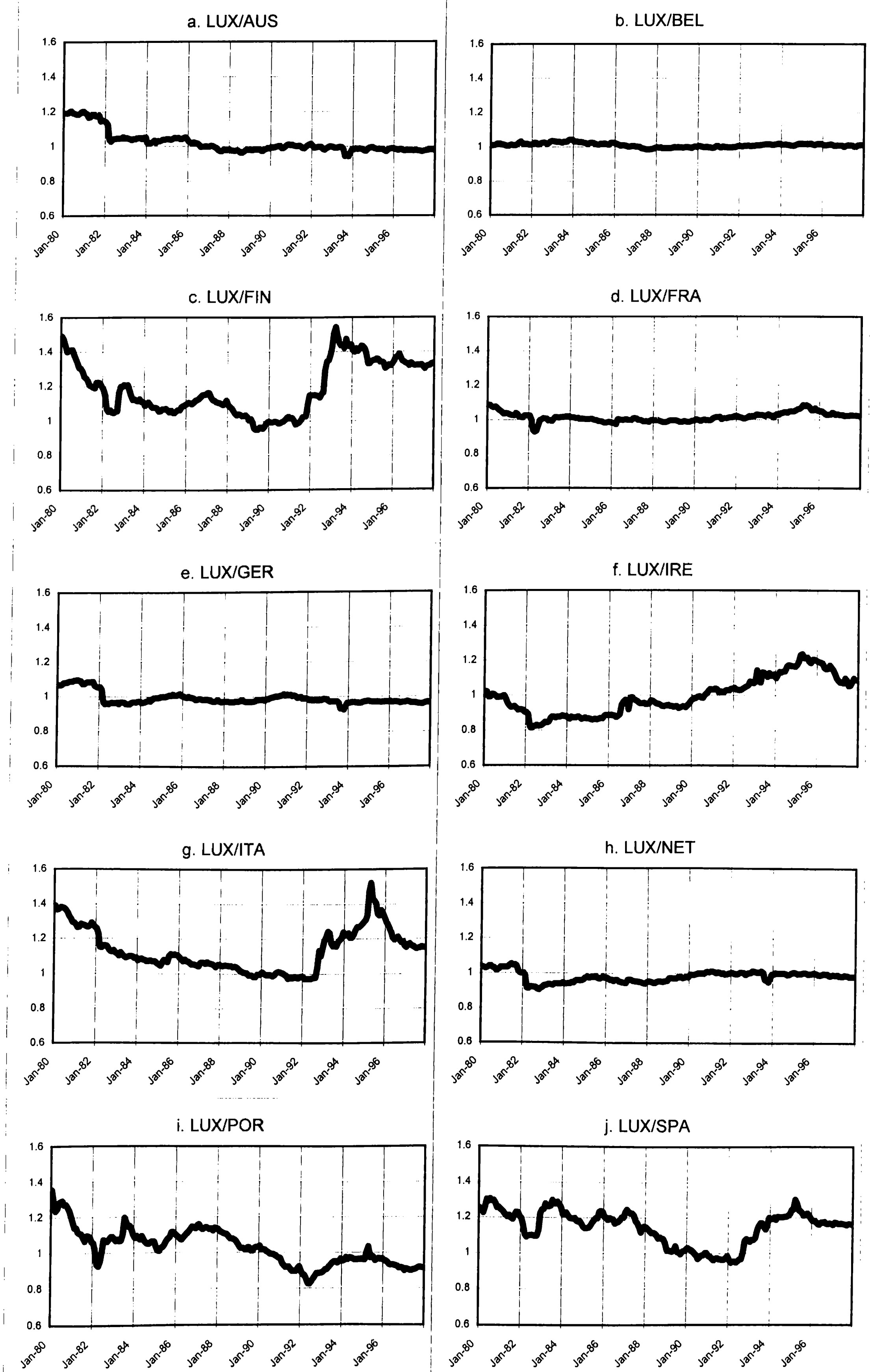


Figure B.9 *- The bilateral real exchange rates for the Netherlands*

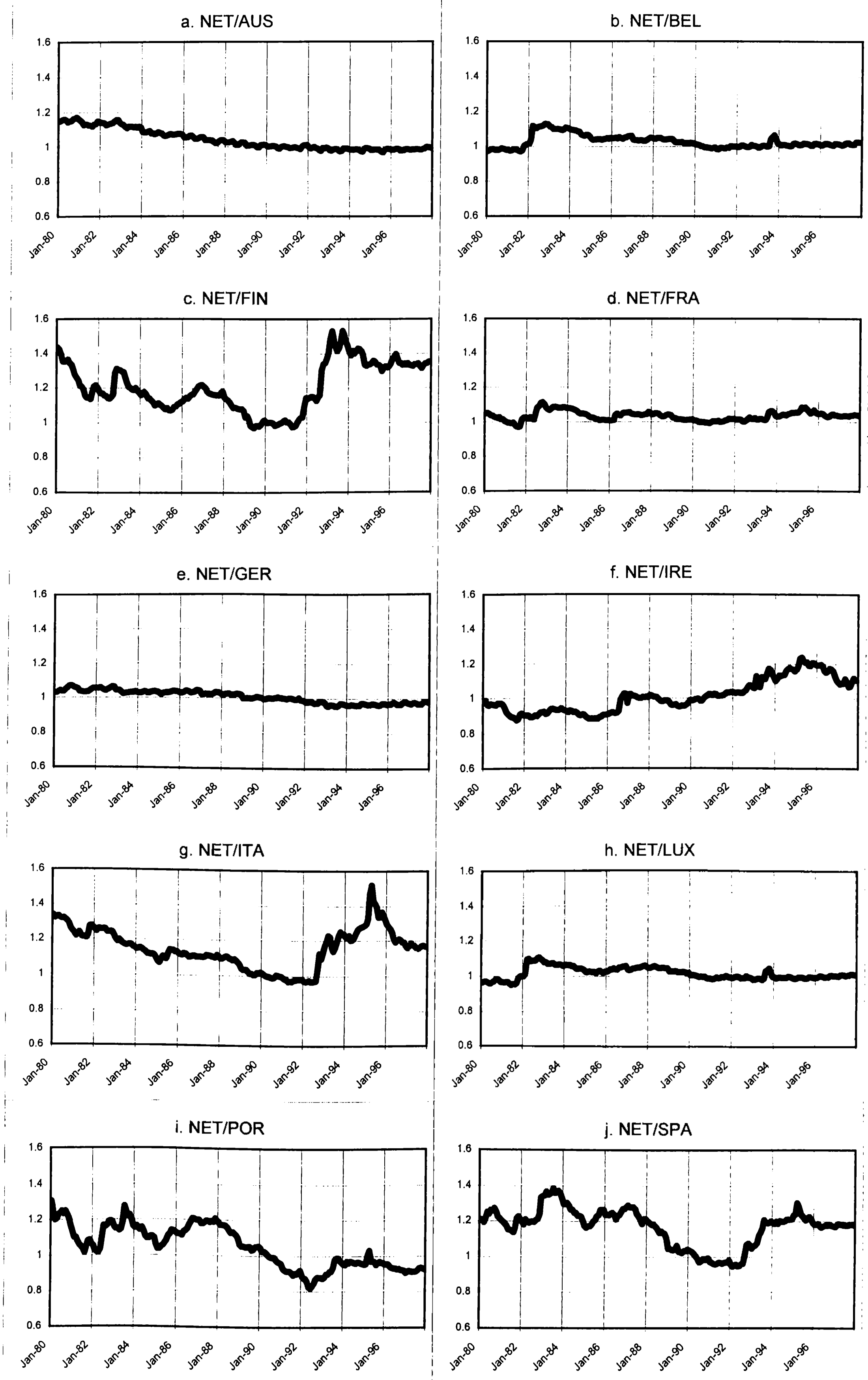


Figure B.10 - *The bilateral real exchange rates for Portugal*

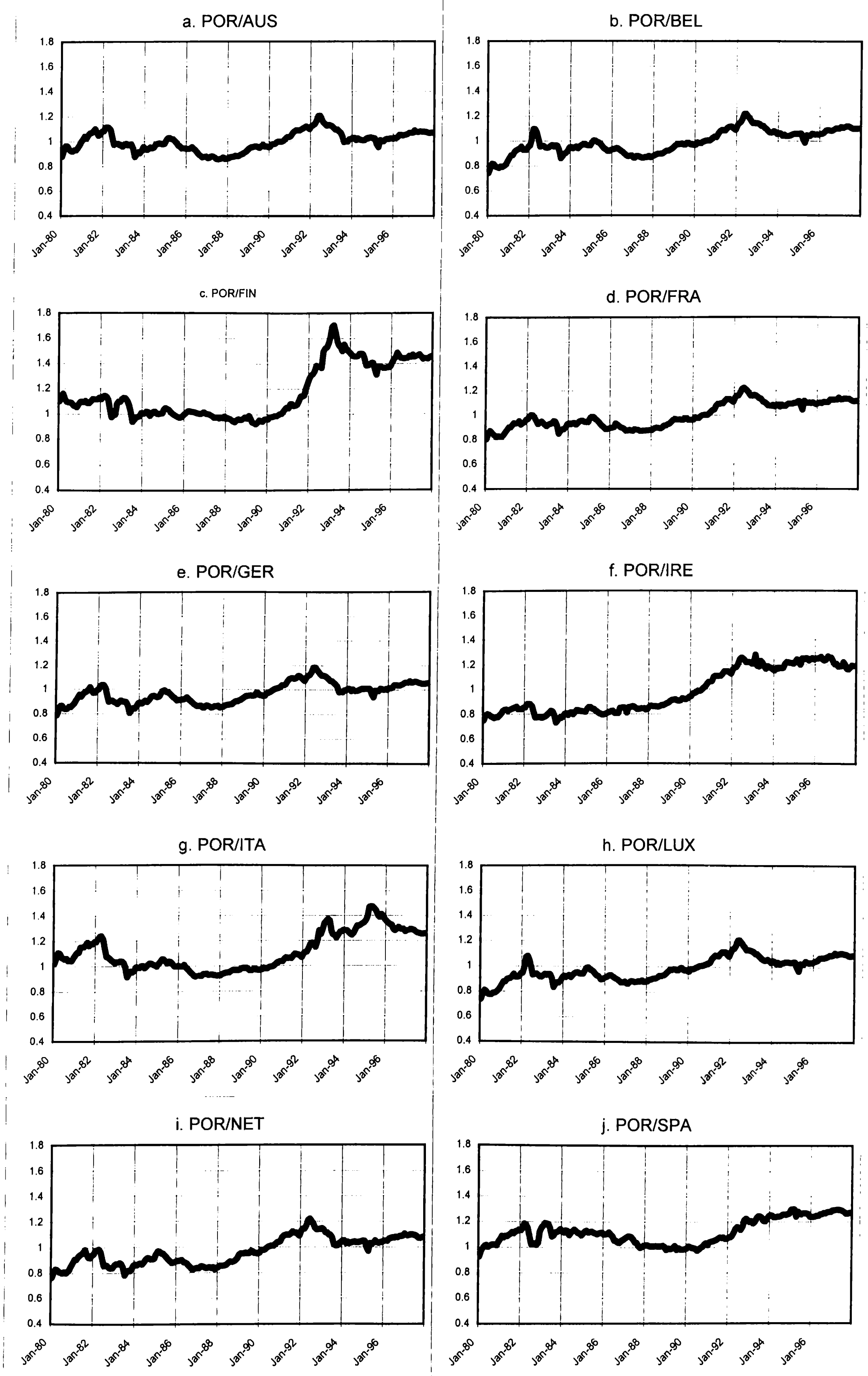
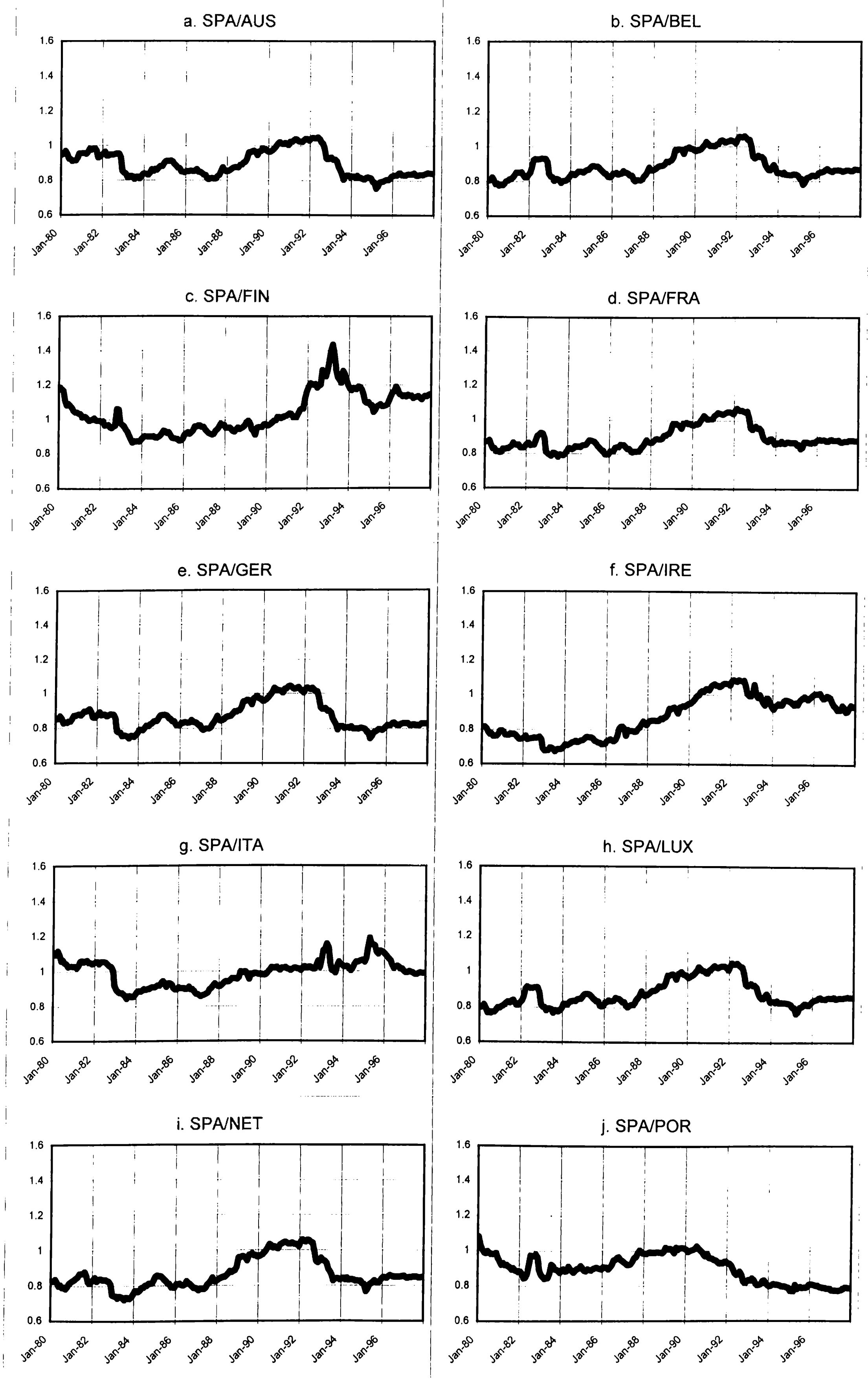


Figure B.11 *- The bilateral real exchange rates for Spain*



C. REAL EXCHANGE RATES: euro against US dollar, Japanese yen and Turkish lira

The real exchange rate indices for euro against US dollar, Japanese yen and Turkish lira are calculated using equation (3.1). Since the price index in euros is not available, a composite index of eleven participating countries is calculated using appropriate weights for each index.

The existing currency of European Union, ECU, is calculated using the trade volume of the participating countries. Danish krone British pound and Greek drachma is included in ECU while they do not participate in the third stage of EMU initially. In addition, Austrian schilling and Finnish markka are not included in the ECU. This rules out the possibility of using ECU weights in calculating the price index for euro.

***Table C.1** - The Composition of the ECU*

Currency	*1979-1984*	*1984-1989*	*1989-1994*	*1995*
German mark	33.0	32.0	30.1	32.7
French franc	19.8	19.0	19.0	20.8
Pound sterling	13.3	15.0	13.0	11.2
Dutch guilder	10.5	10.1	9.4	10.2
Belgian franc	9.3	8.2	7.6	8.4
Italian lira	9.5	10.2	10.15	7.2
Spanish peseta	-	-	5.3	4.2
Danish krone	3.1	2.7	2.45	2.7
Irish pound	1.1	1.2	1.1	1.1
Portuguese escudo	-	-	0.8	0.7
Greek drachma	-	1.3	0.8	0.5
Luxembourg franc	0.4	0.3	0.3	0.3
Total	100.0	100.0	100.0	100.0

Source: Table 2.1, page 58, European Economic Integration: Limits and Prospects, Miroslav N. Jovanovic, 1997, Routledge

Table C.1 above gives the weights of the currencies of participating countries in the ECU. By using the trade volumes of the EMU States, the wights of the currencies in euro are calculated. These weights are given in Table C.2 below.

Table C.2 *- The Composition of the euro*

Currency	*euroweights*
Austrian schilling	3.84
Belgian franc	9.59
Finnish markka	2.06
French franc	17.29
German mark	29.96
Irish pound	2.56
Italian lira	14.01
Luxembourg franc	0.53
Dutch guilder	11.53
Portuguese escudo	1.78
Spanish peseta	6.86